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The Growth of Bilateralism*

Scott L. Baier[†], Jeffrey H. Bergstrand[‡], Ronald Mariutto[§]

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Abstract

One of the most notable international economic events over the past 20 years has been the proliferation of bilateral free trade agreements (FTAs). Bilateral agreements account for 80 percent of all agreements notified to the WTO, 94 percent of those signed or under negotiation, and currently 100 percent of those at the proposal stage. Some have argued that the growth of bilateralism is attributable to governments having pursued a policy of "competitive liberalization" – implementing bilateral FTAs to offset potential trade diversion caused by FTAs of "third-country-pairs" – but the growth of bilateralism can also be attributed potentially to "tariff complementarity" – the incentive for FTA members to reduce their external tariffs on nonmembers. Guided by new comparative statics from the numerical general equilibrium monopolistic competition model of FTA economic determinants in Baier and Bergstrand (2004), we augment their parsimonious logit (and probit) model of the economic determinants of bilateral FTAs to incorporate theory-motivated indexes to examine the influence of existing memberships on *subsequent* FTA formations. The model can predict correctly *90 percent* of the bilateral FTAs within five years of their formation, while still predicting "No-FTA" correctly in 90 percent of the observations when no FTA exists, using a sample of over 350,000 observations for pairings of 146 countries from 1960-2005. Even imposing the higher correct prediction rate of "No-FTA" of 97 percent in Baier and Bergstrand (2004), the parsimonious model still predicts correctly 75 percent of these *rare* FTA events; only 3 percent of the observations reflect a country-pair having an FTA in any year. The results suggest that – while evidence supports that "competitive liberalization" is a force for bilateralism – the effect on the likelihood a pair of countries forming an FTA of the pair's *own* FTAs with other countries (i.e., tariff complementarity) is likely just as important as the effect of third-country-pairs' FTAs (i.e., competitive liberalization) for the growth of bilateralism.

Key words: Free Trade Agreements; International Trade; Endogenous Tariffs
JEL classification: F14; F15

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1 Introduction

"It is first essential to understand why so many countries, in so many different parts of the world, with such different economic systems, at such different stages of development, have all headed in the same direction. There are of course different national circumstances which explain the detailed strategies and timing of the individual initiatives. The overarching force, however, has been the process of competitive liberalization." (Bergsten, 1996)

"Governments lower their external tariffs after joining an FTA." (Ornelas, 2005c)

One of the most notable economic events since 1990 has been the "growth of bilateralism," referring to the phenomenal proliferation of bilateral free trade agreements (FTAs). According to Heydon and Woolcock (2009, pp. 10-11), bilateral preferential trade agreements "account for 80 percent of all PTAs notified and in force; 94 percent of those signed and/or under negotiation; and 100 percent of those at the proposal stage" with the vast bulk of preferential trade agreements being FTAs.[1] In this 20-year period, international trade economists have mostly debated related normative questions – such as whether such agreements are on net welfare-increasing or welfare-decreasing for member countries and/or for nonmembers – and related positive questions – such as whether preferential agreements are "stumbling" or "building" blocks toward global free trade. However, the profession has yet to provide an empirical model that actually explains *what we observe* ***over time***. Moreover, the profession has yet to provide in particular a systematic empirical analysis "testing" Bergsten's hypothesis above that the "overarching force [behind the growth of bilateralism] has been the process of competitive liberalization" versus the importance of endogenous "tariff-complementarity" as the overarching force.

[1]Heydon and Woolcock (2009, p. 10) note that "among projected agreements" 92 percent are planned as FTAs, 7 percent as partial scope agreements, and only 1 percent as customs unions, with customs unions differing from FTAs owing to the former having a common external tariff with nonmembers. For brevity, we refer here to FTAs and customs unions as "FTAs," as most agreements formed in the past 50 years have been FTAs. Our theoretical and empirical analysis will omit partial scope agreements.

The main goal of this paper is to provide a parsimonious empirical model that explains the actual path of bilateralism we have observed *and* evaluates specifically whether the "overarching force" behind the growth of bilateralism is due to competitive liberalization versus tariff-complementarity. In this paper, "competitive liberalization" will refer to the effect of third-country-pair FTAs inducing a pair of countries to subsequently form an FTA to offset potential trade diversion and "tariff complementarity" will refer to the incentive of a pair of countries to form an FTA because either or both of these countries have other FTAs (*own-FTA* effect). We have three specific potential contributions in mind. First, we use new comparative statics from a simplified version of the numerical general equilibrium monopolistic competition model of FTA determinants in Baier and Bergstrand (2004) to show explicitly how – in addition to economic size, economic similarity, proximity, and remoteness – the formation of FTAs affects the utility gains of *potential subsequent* FTA formations. However, we distinguish the effect of a country pair's *own* FTAs with other countries on the net utility gain or loss of the pair forming an agreement (i.e., tariff-complementarity) from the effect of *third-country-pairs'* FTAs on the net utility change of the pair's proposed agreement (i.e., competitive liberalization).[2]

Second, guided by these comparative statics, we formulate and estimate a simple logit (or probit) equation predicting the probability of two countries forming an FTA as a function of both countries' GDP sizes and similarities, bilateral distance, and – in the spirit of gravity-equation theoretical foundations in Anderson and van Wincoop (2003) and Baier and Bergstrand (2009) – "multilateral indexes" of resistance and of "other FTAs" implied by the theory, without having to employ the more demanding spatial econometrics used in Egger and Larch (2008). Moreover, our approach can distinguish empirically the effects of a country pair's *own* FTAs with other countries from *third-country-pair* FTA effects on the likelihood of a pair forming an agreement. We evaluate the empirical model's robustness in a sensitivity analysis.

Third, using our panel of pairings of 146 countries for 46 years (with over 350,000 observations), we employ a "Sensitivity-Specificity" analysis to establish the optimum cutoff probability for whether or not – according to the model's predictions – a country-pair should have a bilateral FTA formed in a given 5-year period. Based on this, we predict correctly approximately 90

[2]We recognize, of course, that many of the observed FTAs between country pairs represent enlargements of existing FTAs and that much of world trade is subject to regional agreements. We will address the implications of enlargements later in the analysis. However, for now we re-emphasize, as noted in Heydon and Woolcock (2009) above, that *94 percent* of the preferential trade agreements that have either been signed or notified (of which the vast bulk are FTAs) are *bilateral* and consequently only 6 percent involve more than two countries. Moreover, *100 percent* of those currently at the proposal stage are bilateral FTAs.

percent of the actual FTA formations (enlargements) for every 5-year-period from 1960-2005 and predict correctly (also 90 percent of the time) "No-FTAs" when no FTAs formed for the same periods. Moreover, if we raise the rate of "true negatives" (or No-FTAs) to 97 percent as in Baier and Bergstrand (2004) (which increases the cutoff-probability), the "true positives" rate falls only to 75 percent, almost as high as that in Baier and Bergstrand (2004) for only a single cross-section of 1431 pairings among 53 countries in 1996 (which was 85 percent). With the area underneath the Receiver Operating Characteristic (or ROC) curve curve at 97 percent (100 percent being a perfect fit), the model implies very high "true positive" and "true negative" and very low false positive and false negative rates of prediction of bilateral FTA formations over time. Moreover, the marginal response probabilities confirm that the effect of a country pair's own FTAs on the likelihood of the pair forming an agreement (tariff-complementarity) is economically and statistically *larger* than the effect of third-country-pairs' FTAs on this likelihood (competitive liberalization). Thus, the results confirm competitive liberalization has been a force behind the growth of bilateralism, but the tariff-complementarity effect is likely to have been just as important a force behind the growth of bilateralism. Finally, these results suggest that the absence of trade-diversion effects found in previous gravity-equation analyses of bilateral trade flows may well be due to the endogenous growth of bilateralism, as noted in Freund and Ornelas (2009).

The remainder of this paper is as follows. In section 2, we discuss the related literature to motivate our analysis. In section 3, we discuss the theoretical framework for motivating our econometric model. In section 4, we provide the econometric specification and data. In section 5, we discuss the main empirical results and provide a robustness analysis. In section 6, we discuss the ability of the model to predict particular FTAs. Section 7 concludes.

2 Motivating Economic Determinants of the Growth of Bilateralism

As background, the starting point for this literature is Baier and Bergstrand (2004), which extended Krugman (1991a,b), Frankel, Stein, and Wei (1995), and Frankel (1997). Using a simple N-country Krugman monopolistic competition model of international trade in slightly differentiated products produced under economies of scale (nested in a 2-sector Heckscher-

Ohlin world), Baier and Bergstrand (2004) showed that the net utility gains from having a bilateral FTA were greater the larger the two countries' economic sizes, the more similar the two countries' economic sizes, the closer the two countries are to each other, the farther the pair is from the rest of the world, the larger the two countries' relative factor endowment differences, and the smaller the difference in the two countries' relative factor endowments relative to the rest-of-the-world. Motivated by comparative statics from the general equilibrium (GE) model, they used a probit model to assess the importance of these variables for predicting the relationships between these determinants and the likelihood of a country-pair *having* an FTA in a particular year (1996) – but not *when* the FTA formed (or enlarged).[3] The postulated relationships between these variables and the likelihood of an FTA were confirmed empirically and the model explained the *existence* of these agreements in a particular year. For example, the model predicted correctly 85 percent of the 286 country pairs with FTAs in existence in their sample using 53 countries in 1996 (the true positives rate) and 97 percent of the 1145 country pairs with no FTAs (the true negatives rate).

While useful to explain the level of bilateralism in a particular year, Baier and Bergstrand (2004) did not address the *growth* of bilateralism across years, specifically, the sequencing (or timing) of actual bilateral FTA formations/enlargements using panel data. Moreover, Baier and Bergstrand (2004) ignored "endogenous bilateralism." Endogenous bilateralism refers to the effect of existing FTAs (or customs unions) on causing subsequent bilateral FTA formations. We will use the term endogenous bilateralism to refer to both the effect of a country pair's own FTAs on changing the probability of the pair forming an agreement – termed here "tariff-complementarity," to be consistent with the endogenous subsequent lowering of external tariffs by a pair of countries after forming an FTA, initially introduced by Bagwell and Staiger (1997, 1999) – as well as the effect of third-country-pairs' FTAs on this likelihood, with the latter being the main idea associated with Bergsten's notion of "competitive liberalization." The first paper to suggest a formal model somewhat related to the spirit of "competitive liberalization" was Baldwin (1993), published as Baldwin (1995). Specifically, Baldwin (1993, 1995) provided a political-economy model of the enlargement process of European economic integration. Starting from an initially exogenous formation of a customs union (the EEC), Baldwin

[3]Baier and Bergstrand's sample included FTAs and customs unions; as there, we refer to both as "FTAs." Another notable study explaining the likelihood of the existence of FTAs, but from a political science perspective, is Mansfield and Reinhardt (2003).

articulated a "domino theory" of enlargement based upon the "demand for membership" of nearby nonmembers. While such a framework can help to explain EEC enlargement, it is not as useful here to help explain conceptually the proliferating formation of new bilateral FTAs; Baldwin' domino theory addresses only enlargement of existing agreements.[4] Nor does Baldwin's domino theory allow for the effects of FTAs among other countries on the same or other continents, which we will refer to (for distinction, henceforth) as "third-country-pair effects."[5]

Game-theoretic analyses of the subsequent effects of FTA formations on members' and nonmembers' external tariffs fall under the literature on "endogenous tariff formation." Economists often refer to the "static" and "dynamic" effects of FTAs. The former refers to the "direct" impact of FTAs on trade flows and on welfare. The latter refers to the effects of FTA formation on *subsequent* external tariffs and FTA formations.[6] While Krugman (1991a) suggested that FTA formations may lead endogenously to higher external tariffs by FTA members, three early influential papers have argued that FTA formations may lead to lower external tariffs by members. Kennan and Riezman (1990) was the first to argue that countries forming customs unions will tend to reduce external tariffs. Richardson (1993) showed that governments may lower external tariffs after forming an FTA to lessen the negative impact on tariff revenue caused by the shift of imports from nonmembers to members. Bagwell and Staiger (1997, 1999) introduced the term "tariff-complementarity effect" to refer to an additional force tending to lower external tariffs, related to changes in terms-of-trade.

[4]In fact, we will show in our simple Krugman economic model with intra- and inter-continental transport costs and consumer-welfare-maximizing governments that a nonmember's demand for membership in an existing FTA attributable to potential trade diversion may be positive or negative depending upon the values of the elasticity of substitution in consumption and initial tariffs, in contrast to Baldwin (1993, 1995).

[5]The terms "endogenous bilateralism," "competitive liberalization," "domino theory," and "interdependence" (cf., Egger and Larch (2008)) are similar but not precisely synonymous. For tractability, however, we need in our paper to be specific. In particular, we will use the term endogenous bilateralism to refer to both the effect of a country i's (js) own FTAs with other non-j (non-i) countries – as well as the effect of all non-ij country pairs' FTAs – on the likelihood of an FTA forming between i and j. We will reserve the terms competitive liberalization and interdependence to refer to only the effect of non-ij (or third-country-pairs') FTAs on the likelihood of an FTA forming between i and j, as examined in Egger and Larch (2008). We will reserve the term "domino effect" to refer specifically to Baldwin's political-economy model, which focused only upon "enlargement" of an existing agreement, i.e, the effect of the existence of an FTA between countries k and j on the likelihood of an FTA forming between countries i and j *and* simultaneously between i and k. Baldwin and Rieder (2007) find evidence of "demand-side" membership pressure. The term "endogenous bilateralism" is not exclusive to the effects of just other FTAs on subsequent FTA formations. It applies to other contexts also, such as the effect of multilateral liberalization on FTA formations, cf., Freund (2000). FTA formations, moreover, may also influence subsequently multilateral liberalizations, cf., Ornelas (2005a,b,c) and Estevadeordahl, Freund, and Ornelas (2008). Unfortunately, space precludes an exhaustive summary of this large literature.

[6]Kemp and Wan (1976) showed that, in a world with lump-sum redistributions, there exists a vector of tariffs such that no country is worse off from the creation of a customs union.

In a series of influential papers, Ornelas (2005a,b,c) finds several useful results, using a game-theoretic model with linear demand and cost functions, endogenous tariffs, perfect or imperfect competition, allowing special interests to influence government objectives, but no international trade costs. For instance, Ornelas (2005c) finds:

> *"Governments lower their external tariffs after joining an FTA. This reduction is such that it promotes greater trade flows even between FTA members and outsiders, the discrimination against the latter embodied in the FTA notwithstanding. This creation of trade surely benefits the outside countries, but members' welfare may in principle fall under a generic arrangement. Governments, however, support only FTAs that enhance their own countries' welfare, in spite of their political motivations. Therefore, when an FTA is actually implemented,* ***every*** *country gains from it. In addition, FTAs can also play a role in reducing obstacles to liberalization on a multilateral basis,...." (Ornelas, 2005c, p. 491)*

More recently Saggi and Yildiz (forthcoming, 2010) show that in a world with asymmetric economic sizes, world free trade is a *stable* equilibrium *if and only if* countries are allowed to form bilateral FTAs. They conclude that "we need to better understand *why* countries choose to enter into bilateral agreements. . . [as the] existing literature has tended to pay little attention to this issue." Moreover, Ornelas (2005a) notes that – despite a rich theoretical literature on endogenous tariff formation – *empirical* evaluations of the recent wave of bilateral FTAs "remain relatively scarce" (p. 1718).

Empirically, only one published paper has addressed systematically the effects of existing FTAs on predicting subsequent FTAs over time. Egger and Larch (2008) extended the probit specification in Baier and Bergstrand (2004) to a panel setting and to include a "spatial lag" (i.e., spatial econometrics) to investigate three hypotheses: the existence of preferential trade agreements (PTAs) – which include FTAs, customs unions, and all one-way and two-way preferential arrangements – among *third-country-pairs* increases the probability of PTA enlargements; the existence of PTAs among third-country-pairs increases the probability of new PTAs among country pairs; and higher trade costs lessen both of the previous effects of third-country-pair

FTAs. All three hypotheses were tested by expanding the Baier-Bergstrand empirical probit model to include a spatially-weighted matrix that aggregated for each country-pair for each year all "third-country-pairs" into one artificial pair reflecting FTA membership in all other pairs (i.e., the "spatial lag").

Our paper distinguishes itself from this important empirical contribution in three ways. First, and most importantly, Egger and Larch (2008) considers only the effect of third-country-pairs' FTAs on subsequent FTA formation, i.e., competitive liberalization (or what they term "interdependence"). The construction of a spatial-weighting among only "third-country-pairs" in Egger and Larch (2008, p. 387) implied that they could only examine the effect of PTAs signed by "non-ij" country pairs on the likelihood of a PTA between i and j. Our paper *disentangles* the effects of i's (or j's) FTAs with other countries on the likelihood of an FTA between i and j (what we will refer to as "tariff-complementarity") from the effects of "non-ij" third-country-pairs' FTAs (what we will term "competitive liberalization" or interdependence). We do this by introducing the notion of "multilateral (and ROW) indexes of other FTAs" – in the spirit of Anderson and van Wincoop's (2003) "multilateral resistance" terms influencing bilateral trade flows (detailed later). We will show empirically that the effects of two countries' (i and j) FTA memberships with other countries are more important for predicting the likelihood of i and j forming an agreement than an FTA among a non-ij pair, consistent with comparative statics from our numerical GE model.

Second, estimation of the probability of an FTA using spatial econometrics is *much* more demanding than estimating a simple logit or probit model. A spatial lag introduces multiple integrals into the likelihood function, rendering simple maximum likelihood estimation (MLE) infeasible. Also, the error term is likely heteroskedastic with a spatial lag, leading to inconsistent parameter estimates if not accounted for. Hence, the spatial binary choice model cannot be estimated simply by MLE, as can our approach, and estimation demands of a spatial-lag model are not trivial.[7] Our model captures endogenous bilateralism using a standard logit (or probit) model with a simple linear multilateral FTA index for each of two countries – as well as a

[7]Briefly, for cross-section estimation, Egger and Larch (2008) apply a Bayesian Markov-Chain Monte Carlo model to estimate the parameters of interest using Gibbs sampling. Sampling from conditional distributions yields a large set of parameter draws. The corresponding estimates of the posterior moments thereof can be shown to converge in the limit to the joint posterior distribution of the parameters. For estimation, they rely on a chain based on 10,500 draws. The first and second moments of the chain are computed after skipping 500 burn-ins. Hence, 500 draws are dropped to ensure that there is no systematic information left in the random number generation process for the remaining 10,000 draws. See Egger and Larch (2008) for details on how they estimate their model.

Rest-of-World (ROW) FTA index for the pair – motivated directly from the theoretical model.

Third, and of lesser importance, the number of PTAs that formed bilaterally in the past 50 years is about five times the number of FTAs (and customs unions) only; Egger and Larch (2008) provided results for all PTAs, but not for the much smaller sample of FTAs. Our paper examines FTAs, customs unions, common markets and economic unions only using a new data set of all such agreements in the world bilaterally for 195 countries for 1960-2005 (cf., www.nd.edu/ jbergstr). Nevertheless, all three hypotheses in Egger and Larch (2008) were confirmed, with the single positive and statistically significant coefficient estimate for the spatial-interdependence term confirming the importance of interdependence (i.e., competitive liberalization). Thus, Egger and Larch (2008) was the first paper to demonstrate econometrically the empirical validity of the effect of "third-country-pairs' PTAs" for influencing the formation/enlargement of *subsequent* bilateral PTAs, that is, evidence of "competitive liberalization." We will compare our results to theirs later.

This paper has three potential contributions in mind. First, we generate, using a general equilibrium theoretical model, comparative statics for motivating three economic variables that capture the role of "endogenous bilateralism" in influencing the utility gains of an FTA for a country-pair in the presence of inter- and intra-continental trade costs. We start with a simplified version of the general equilibrium model of FTA determinants in Baier and Bergstrand (2004).[8] We use the model to generate two important comparative statics. First, we evaluate the effect on the utility gain of a country-pair ij from an FTA *attributable to* an existing FTA between another country-pair kl, which captures the influence of Bergsten's "competitive liberalization" hypothesis; we will refer to this scenario as a "third-country-pair" effect in the spirit of Egger and Larch (2008). Second, we evaluate the effect on the utility gain of a country-pair ij from an FTA *attributable to* an existing FTA between country-pair ik (or jl, or both), which we refer to as an *own-FTA* (or "tariff-complementarity") effect. We distinguish the own-FTA effects from the third-country-pair-FTA effects; the marginal utility gains from the former (and consequently the effect on the probabilities) may be larger than those from the latter. A special case of competitive liberalization is Baldwin's "domino theory," which suggests country i may gain more from forming an FTA with country j – *and simultaneously one with country* k – if j and k already have an agreement (e.g., the European Community's enlargement). We will

[8]Since the trade flows underlying the utility function are determined by a gravity equation, our framework could alternatively be motivated using an Eaton and Kortum (2002) Ricardian model.

discuss this case later under caveats, but re-emphasize that we are trying to explain "what we observe over time" predominantly and more recently, which is the growth of "bilateralism" not "regionalism," cf., Heydon and Woolcock (2009).[9]

Second, the theoretical model suggests that the potential welfare gain from a bilateral FTA of country-pair ij is influenced in every year by the status of i's (j's) FTAs with every other non-j (non-i) country – as well as FTAs between "third-country-pairs" (say, kl) – which influence i's and j's multilateral prices. In the spirit of the notion of "multilateral resistance" from recent theoretical foundations for the gravity equation in Anderson and van Wincoop (2003) as modified using the approximation method in Baier and Bergstrand (2009), the theoretical model suggests simple linear indexes of each country's "multilateral" and country-pairs' "ROW" FTAs. For instance, country i possesses a "multilateral FTA" (or inverse-resistance) index, which measures in year t (a simple or weighted average of) country i's FTAs with every other non-j country; country j has an analogous index. As the theory will suggest, these could have positive effects on the likelihood of an FTA between i and j. Moreover, each country-pair ij has a "ROW FTA index" which measures the degree of bilateralism it faces with every other non-ij pair (say, kl) in every year t; we will show that such "third-country-pair" (kl) FTAs could improve the likelihood of an FTA between i and j (holding constant the multilateral FTA indexes). While we will discuss the conditions under which such effects could be positive or negative, our theory does suggest under several sensitivity analyses that the multilateral FTA indexes should have a larger impact on the utility gain for ij of a bilateral FTA than the ROW FTA indexes. Such measures can be readily introduced into a standard logit (or probit) equation determining the likelihood of a bilateral FTA, without having to employ spatial econometrics as in Egger and Larch (2008). Indeed, the marginal response probabilities for own-FTA effects *are* larger than those for third-country-pair-FTA effects. And, importantly, these own-FTA marginal response probabilities are just as large as the marginal response probabilities for the other economic determinants in the logit equation. Moreover, by applying the linear-approximation approach of Baier and Bergstrand (2009), we also provide theory-based

[9] As in Baier and Bergstrand (2004) and Egger and Larch (2008), our starting point is that governments are assumed to choose trade policies to maximize national welfare because this assumption has been a standard assumption in trade theory, cf., Baldwin and Venables (1995), Bond, Riezman, and Syropoulos (2004), and Kowalczyk and Riezman (2009). As the introductory quote in Bergsten (1996) notes, while national (political) circumstances differ across countries, in a large cross section of determinants of trade policies the "overarching" force of competitive liberalization and maximization of national economic welfare likely dominates policy decisions. We will discuss also the restrictiveness of our assumption given recent game-theoretic settings with endogenous protection under caveats.

measures of "multilateral resistances" of country-pairs to avoid the typical *ad hoc* remoteness variables included in Baier and Bergstrand (2004) and Egger and Larch (2008), as well as in many gravity-equation analyses.

Third, adopting a methodology suggested by the literature on Receiver Operating Characteristic (ROC) curves for selecting optimum cutoff probabilities endogenously, we find that our multilateral-FTA-index-enhanced logit model can correctly predict approximately *90 percent* of the transitions of country-pairs from "No-FTA" status to FTA status *within five years* of their formation – as well as correctly predicting approximately 90 percent of the observations when no transition occurs. (Also, the model holds up well when including unobserved fixed effects and time dummies; the five-variable fixed-effects logit model has a pseudo-R^2 of 87 percent.) Moreover, even raising the rate of true negatives (no FTA predicted when none exists) to 97 percent as in Baier and Bergstrand (2004), the rate of true positives (FTA predicted within five years of its formation) falls only to 75 percent, which is only ten percent below the rate in Baier and Bergstrand for predicting the *existence* of an FTA in a single cross-section (1996).[10]

3 Theoretical Framework and Comparative Statics

This section has four parts. Section 3.1 summarizes the standard Krugman monopolistic competition model of international trade, which was at the heart of the Baier and Bergstrand (2004) model. Section 3.2 discusses the parameterization of the numerical version of the GE model. Section 3.3 discusses five comparative static results from the numerical GE model. Section 3.4 addresses some caveats and reports on the robustness of these comparative statics with respect to varying parameter values.

[10]There are also three related working papers in this area. Motivated also by a simple Helpman-Krugman model, Bergstrand, Egger, and Larch (2009) explain the timing of FTAs using an econometric duration model. By introducing a simple "stair-step" trade-cost pattern to an N-country Helpman-Krugman model, Bergstrand, Egger, and Larch (2009) generates a "demand-for-membership" schedule that is increasing in membership-size of the closest FTA and a *finite* "supply-of-membership" schedule that is decreasing in membership-size. Their empirical model supports the implied quadratic relationship between likelihood of an FTA and the number of members in nearby FTAs, but does not address tariff-complementarity and competitive liberalization effects explicitly. Baldwin and Jaimovich (2009) introduce a measure of trade-weighted-averages of two countries' FTAs with other countries to estimate the effect of (what they term) "contagion" in bilateralism, for which they find evidence; however, their measure of contagion was not motivated by a formal model (as here) and does not distinguish between tariff-complementarity and competitive liberalization effects. Chen (2008) provides a Cournot-model based approach to examine the determinants of timing of FTA events and the role of endogenous regionalism. However, her focus is distinguishing theoretically and empirically how the "nature" of the *existing* agreement – "empty-network," "exclusive network," or "hub-and-spoke network" – affects the probability of two countries forming an agreement.

3.1 The Model

The starting point is Baier and Bergstrand (2004), or B-B, which provided a Krugman model of international trade with two monopolistically-competitive sectors and two factors of production, where each sector produced slightly-differentiated goods under economies of scale internal to the firm, in the presence of tariff rates and intra-continental and/or inter-continental trade costs. To focus on endogenous bilateralism in this paper, we assume here only one monopolistically-competitive sector and one factor of production (labor), where goods are slightly differentiated in consumption and produced under economies of scale; this is a simplified version of the B-B model and a "workhorse" model of international trade.

We note now that we ignore intentionally certain important theoretical issues, as the *primary* focus of our paper is a potential ***empirical*** – not theoretical – contribution. First, recent developments in trade theory address heterogeneous firms, cf., Melitz (2003). Arkolakis, Costinot, and Rodriguez-Clare (2009) find that, in the class of models used here – Krugman (1980), as well as in Eaton and Kortum (2002), Anderson and van Wincoop (2003), Melitz (2003), and some variations of Melitz (2003) – with two critical elements (CES utility and a gravity equation), there exists a common estimator of the "gains from trade." This estimator depends upon only two aggregate statistics: the share of expenditures of a country on imports and a gravity-equation-based estimate of the elasticity of trade flows with respect to variable trade costs. Consistent with that paper, Feenstra (2009) finds in a standard Melitz-type model that the extensive margin of imports has a welfare contribution as a result of trade liberalization that exactly offsets the welfare loss from the reduced extensive margin of domestic goods. Hence, for our purposes and in this class of models, this recent research suggests that heterogeneity across firms in a sector is not central for analyzing the *welfare* effects of trade liberalization.

Second, we have already alluded to recent important developments in game-theoretic settings that suggest that the welfare implications of FTAs discussed below could be potentially clarified or altered by incorporating endogenous tariff formation. Bagwell and Staiger (1997, 1999) emphasize the "tariff-complementarity" effect, finding in a static framework that complements ours that the formation of an FTA between a country pair can lead to both countries reducing their external tariff on the non-member. Bond, Riezman, and Syropoulos (2004) also find in a strategic setting the tariff-complementarity effect; in fact, they find that the reduction by members of external tariffs is so large that the welfare of the rest-of-world (ROW) improves, resulting in a rise of ROW tariffs. Ornelas (2005a) provides another force potentially leading to the tariff-complementarity effect; if markets are oligopolistic, external tariffs may fall after the FTA forms because FTAs make profit-sharing more difficult. We will assume exogenous tariffs; however, we will report the sensitivity of our model to endogenous (Nash equilibrium) tariffs in the robustness analysis later.[11]

Third, in reality governments' objective functions are not constrained to only maximizing national welfare. In fact, political factors matter. Recent theoretical political economy models by Grossman and Helpman (1995) and Krishna (1998) suggest that *trade-diverting* FTAs are more likely to surface, once campaign contributions and special interests are accounted for. Yet, Ornelas (2005b,c) shows that such agreements are less likely, once these models allow for endogenous tariff formation. Though the results are founded upon linear demand and cost functions and ignore transport costs, Ornelas (2005c) model has some very powerful implications. Governments tend to lower external tariffs after forming an FTA. This results in greater trade flows between members *and* between members and nonmembers. Governments support only FTAs that enhance their own countries' welfare, in spite of political motivations. Also, FTAs can play a role in reducing obstacles to multilateral liberalization, helping spur global free trade, as in Saggi and Yildiz (forthcoming, 2010). Freund and Ornelas (2009, p. 24) conclude that the limitation in Baier and Bergstrand (2004) of not accounting for political-economy factors may not be a "problem after all."

Our purpose in this section is to offer a very parsimonious model that generates some comparative statics to guide construction of useful empirical multilateral and ROW indexes of "other FTAs" that ideally will help to explain *what we observe* about the sequencing of bilateral FTAs and potentially inform us about whether or not competitive liberalization (due to third-country-pair FTAs) is the "overwhelming" force behind the growth of bilateralism or whether tariff-complementarity is. As discussed above, the model below has some limitations. However, to summarize the previous discussion, the literature on endogenous tariff setting tends to suggest that FTA partners are likely to subsequently reduce external tariffs following formation of an FTA with or without political contributions, the FTAs that form are likely to

[11] Another important paper, Goyal and Joshi (2006), using endogenous tariff formation show also feasible conditions under which bilateral FTAs lead to further bilateral FTAs, as optimal tariffs of a member on third countries are a declining function of the number of FTAs the country has, consistent with our results below.

be welfare-enhancing, and bilateralism may be a critical process toward ensuring an ultimate *stable* global free trade equilibrium.

3.1.1 Consumers

The model consists of N countries and one sector. Each country j hosts a single representative consumer who derives utility from the consumption of goods. Utility is characterized by a taste for variety which is captured formally by Dixit and Stiglitz (1977) preferences with a constant elasticity of substitution (CES). Let $c_{ij}(k)$ be consumption in country j by the representative consumer of the differentiated good produced by firm k in country i. Let σ denote the elasticity of substitution in consumption between varieties of goods with $\sigma > 1$. Let n_i be the number of varieties of goods produced in country i. The utility function u_j is given by:

$$u_j = \left[\sum_{i=1}^{N} \int_{n_i} c_{ij}(k)^{\frac{\sigma-1}{\sigma}} dk \right]^{\frac{\sigma}{\sigma-1}}. \tag{1}$$

Within a country, firms are assumed symmetric, which then allows eliminating firm notation k. We assume one factor of production, labor (L). Let w_j denote the wage rate of the representative worker in country j.

In this model, we include Samuelson iceberg-type trade costs (inclusive of government-mandated trade barriers) that are allowed to be asymmetric among all country pairs. We assume that t_{ij} units of a good have to be shipped from county i to ensure that one unit arrives in country j (assuming $t_{ij} \geq 1$ and $t_{ii} = 1$). Also, let τ_{ij} denote the gross tariff rate on goods imported into j from i (assuming $\tau_{ij} \geq 1$ and $\tau_{ii} = 1$).

The consumer is assumed to maximize equation (1) under the budget constraint:

$$w_j + TAR_j = \sum_{i=1}^{N} n_i p_i t_{ij} \tau_{ij} c_{ij}, \tag{2}$$

where TAR_j is tariff revenue in j redistributed lump-sum back to households in j and p_i is the producer's price of good g in country i. This maximization yields a set of demand equations for national economy j with L_j households:

$$X_{ij} = \frac{n_i \left(p_i t_{ij} \tau_{ij}\right)^{-\sigma}}{\sum_i (n_i/\tau_{ij})(p_i t_{ij} \tau_{ij})^{1-\sigma}} Y_j, \tag{3}$$

where X_{ij} is demand in country j for goods from country i and Y_j denotes national income in j. In the absence of lump-sum tariff redistributions, the term (n_i/τ_{ij}) in equation (3) reduces to n_i.

3.1.2 Firms

All firms in the industry are assumed to produce under the same technology. The output of goods produced by a firm in country i, denoted by g_i, requires l_i units of labor, as well as an amount ϕ of fixed costs, expressed in terms of units of labor. The production function – similar to that in Krugman (1980) – is given by:

$$l_i = \phi + g_i, \tag{4}$$

where we assume as traditional a constant marginal product of labor (set to unity). Firms maximize profits subject to the technology defined in equation (4), given the demand schedule derived in Section (3.1.1). In this model, profit maximization leads to a constant markup over marginal production costs and there are zero profits in equilibrium due to free entry and exit. Profit maximization ensures:

$$p_i = \frac{\sigma}{\sigma - 1} w_i. \tag{5}$$

Zero profits in equilibrium ensure:

$$g_i = \phi \left(\sigma - 1\right). \tag{6}$$

3.1.3 Factor Endowment Constraint

We assume that endowments of labor, L_i, are exogenously given and internationally immobile. Assuming full employment, the following factor market condition holds:

$$L_i = n_i l_i \tag{7}$$

or

$$n_i = (\phi\sigma)^{-1} L_i. \tag{8}$$

The zero profit conditions and the clearing of goods and factor markets lead to balanced multilateral trade for each economy.

3.2 Numerical Simulation: Parameter Selection

The purpose of this section is to calibrate the model for a representative world economy with potentially asymmetric labor endowments and bilateral trade costs. Our model can then be simulated to motivate several potentially testable hypotheses regarding relationships between economic characteristics of pairs of countries and the sequencing of either an FTA formation or enlargement.

We calibrate the model identically to that in B-B; since the model is simpler, some parameters specified there are absent here. For the utility function, we have one parameter, the elasticity of substitution between varieties of goods (σ). We set σ=4 as in B-B. For technology, we set the fixed cost term in the production function to unity ($\phi = 1$), without loss of generality. Initially, factor endowments of labor are assumed identical across all countries in the symmetric benchmark equilibrium with values of $L_i = 100$ for all countries. In this paper, we focus on one industry, leaving analysis of sectoral differences for subsequent research.

The number of firms, product varieties, labor employments, wage rates, consumption levels, and price levels in each country can be determined uniquely given the parameters of the model (σ, ϕ) and initial transport costs, tariffs, and labor endowments. Following B-B, we separate transport costs into intra-continental and inter-continental "iceberg" components. Let a denote the portion of the good that "melts" intra-continentally and b the portion that melts inter-continentally; hence, within continents $t_{ij} = 1/(1-a)$ and between countries on different continents $t_{ij} = [1/(1-a)][1/(1-b)]$. We will allow both a and b to vary between their full potential values of 0 and 1 to show sensitivity of the results to variation in transport costs.

As in B-B, we assume the existence in each country of a social planner, which sets tariff rates ($\tau_{ij} - 1$) initially at 0.3. Based upon initial parameter values, the social planner in each country considers whether its representative consumer's utility would be better off or worse off from forming an FTA. For a country's planner to form a new – or join an existing – FTA, the change in utility from doing so must be positive.[12]

Since we set effectively only three parameters (σ, ϕ, and τ) – as a and b will be allowed to vary between 0 and 1 and L will be allowed to vary – we will evaluate the robustness of the comparative statics later to changes in the levels of σ, ϕ, and τ using a sensitivity analysis.

3.3 Numerical Simulation: Comparative Static Results

We use the numerical version of our model to generate five comparative statics, including two regarding the effects of *existing* FTAs on the utility gain for two countries of forming an agreement. The first three hypotheses discussed in section 3.3.1 address three comparative statics regarding distance, economic size of country pairs, and dissimilarity in country-pairs' economic sizes. In section 3.3.2, the next two hypotheses address two comparative statics regarding the effects of endogenous bilateralism. Following B-B, initially we assume three continents $(1, 2, 3)$ with two countries on each continent (A, B).[13]

3.3.1 Bilateral Economic Determinants

This section presents three hypotheses for testing later empirically. All three are subtly different from similar hypotheses discussed in Baier and Bergstrand (2004), with the distinctions explained for each hypothesis.

Hypothesis 1: The utility gain from (and likelihood of) an FTA between two countries increases as the distance between them decreases.

One of the key implications from Krugman (1991a,b), Frankel, Stein, and Wei (1995), Frankel (1997), and Baier and Bergstrand (2004) is that *natural* (intra-continental) FTAs are unambiguously welfare superior to unnatural (inter-continental) FTAs; hence, two countries' social planners are more likely to form an FTA the smaller the distance between them (and if they share the same continent). For a given distance between a country-pair and ROW, the closer are two countries, the lower their transport costs and consequently the higher their trade

[12] The value of 0.3 was originally chosen in B-B following Frankel (1997). As noted in B-B, the ideal approach would be to consider the Nash equilibrium tariffs; the Nash equilibrium tariffs in a post-integration situation are likely to differ from those in the pre-integration situation. In our robustness analysis, we will discuss both the sensitivity of our comparative statics to different initial tariff rates as well as to allowing endogenous (Nash equilibrium) tariffs. We note that the calculation of the Nash equilibrium tariffs in the six-country case of B-B yields a pre-integration tariff rate of approximately 0.3 for all countries (assuming symmetry).

[13] A "visualization" of the "world" is shown in Figure 4, to be discussed later.

volume. Elimination of the *ad valorem* tariff between close FTA members alleviates the price distortion on a large amount of trade, improving real income and utility of consumers more in intra-continental FTAs. In this class of models, all trade volume increases are at the intensive margin.[14]

However, all the studies just noted above considered the case when *all* continents' countries formed an FTA. This led to the comparative static result that unnatural FTAs were welfare-*decreasing*. However, ignoring for now "endogenous bilateralism," the comparative-static effect in this model from only *one* country-pair forming an agreement is different, and shown in Figure 1. Two results are worth noting. First, an FTA between one pair – natural or unnatural – is always welfare improving. With only one FTA, there is less trade diversion occurring, so that even an *unnatural* FTA improves the two members' utility. This is consistent with the formation of unnatural (inter-continental) FTAs – such as the U.S.-Australia FTA – which is a theoretical result not found in any previous study. Second, as in previous studies, natural FTAs are always welfare-improving relative to unnatural FTAs. In the context of our qualitative choice model, this suggests that two countries will have a higher probability of an FTA if the welfare benefits (of trade creation) outweigh the welfare costs (of trade diversion), consistent with *Hypothesis 1*.

Hypothesis 2: The utility gain from (and likelihood of) an FTA between two countries increases as both countries' economic sizes increase proportionately (holding constant their relative size).

In the previous scenario, all countries are equivalently sized in labor (and GDP). As in B-B, we now introduce asymmetric sizes in terms of absolute factor endowments to determine the scale-economies cum taste-for-variety effects. For brevity, we limit our comparative statics to natural trade partners only. We allow countries on continent 1 ($1A, 1B$) to have larger absolute endowments of labor than countries on continent 2 ($2A, 2B$), and $2A$ and $2B$ to have larger absolute endowments than countries on continent 3 ($3A, 3B$); however, for any country-pair on the same continent, GDPs are identical. As above, we consider a single FTA between a pair of countries on one continent (different from B-B).

[14] The model assumes homogeneous productivities across firms in a country, as addressed earlier in section 3.1. There are other approaches as well to suggest why FTAs tend to be formed among closer, rather than distant, countries. Zissimos (2009), for instance, adapts the model of Yi (1996) to show that – since more rents are dissipated through transportation between regions rather than within them – regional FTAs eliminate the greater harmful "rent-shifting" among members and also has greater beneficial terms-of-trade effects. This reduction of harmful "rent-shifting" pushes countries more toward forming regional FTAs.

Figure 2 presents two surfaces, with the top one illustrating the welfare gain for either country $1A$ or $1B$ of an FTA between large economies $1A$ and $1B$ and the bottom surface illustrating the gain for either country $3A$ or $3B$ of an FTA between small economies $3A$ and $3B$. We emphasize two results. First, an FTA between two small economies is *still* welfare-improving. This result differs from that in Figure 2 of B-B where all natural partners went into an FTA simultaneously. With only one agreement at a time (and ignoring still endogenous bilateralism), even small countries can benefit from a bilateral FTA; hence, the trade-creation effect dominates the trade-diversion effect. This comparative-static result – that small countries can benefit on net from FTAs on the same continent – is new. Second, as in B-B, large countries benefit more than small countries from FTAs. Intuitively, welfare gains from an FTA should be higher for countries with larger absolute factor endowments (and thus larger real GDPs). An FTA between two large partners $(1A, 1B)$ increases the volume of trade (at the intensive margin) in more varieties than an FTA between two small partners $(3A, 3B)$ and reduces trade in fewer varieties from nonmembers than two small partners would, improving utility more among two large countries relative to that among two small countries.[15] Also, the consequent larger increase in trade among two large economies from a bilateral FTA causes a larger net expansion of demand and hence a larger rise in real income (and terms of trade). Small countries $3A$ and $3B$ face considerable trade diversion when $1A$ and $1B$ form an FTA; the fall in relative demand for the small countries' production causes an erosion of terms of trade. In the context of our qualitative choice model later, this suggests that two countries with large (but equal) real GDPs should have a higher probability of an FTA than two countries with small real GDPs, consistent with *Hypothesis 2*.

Hypothesis 3: The utility gain from (and likelihood of) an FTA between two countries increases the more similar their economic sizes (for a given total real GDP of the country-pair).

In this class of models, the more similar are the real GDPs of two countries on the same continent the larger the welfare gains from an FTA, for a given total GDP of the pair. In the previous comparative static, countries on the same continent had identical economic sizes. If $1A$ and $1B$ have identical shares of the two countries' factor endowments, the formation of an FTA provides gains from an increase in the volume of trade (at the intensive margin) as the tariff distortion is eliminated on much trade. By contrast, if $1A$ has virtually all of the labor

[15] This is consistent with Bernard, Jensen, Redding, and Schott (2009) that cross-sectionally the bulk of trade can be explained by the extensive margin (number of varieties).

on continent 1, formation of an FTA provides little welfare increase, since there is virtually no trade between $1A$ and $1B$ because $1B$ produces few varieties.

Figure 3 illustrates this. The top surface shows the welfare gain for $1A$ when $1A$ and $1B$ are identically sized. The bottom surface shows the welfare gain for $1A$ when it has a larger share of the continent's labor force. Since $1A$ is larger, it gains less from an FTA with $1B$. This result was found already in B-B, but we present it here for completeness. In the context of our qualitative choice model, this figure suggests that two countries with more dissimilar economic sizes should have a lower probability of an FTA, consistent with *Hypothesis 3*.

3.3.2 FTA Determinants of Subsequent FTAs

The following two hypotheses (*Hypotheses 4* and *5*) address the effects of *existing* FTAs on the welfare gains of *subsequent* FTAs. It is important to note, however, that our model is a static one (a single period), so there is no formal sense of "time." The model can, however, generate numerical welfare effects of an FTA between a country-pair *conditioned upon* various alternative scenarios, such as an FTA or no FTA between another country-pair. It is in this manner we use our model's comparative statics to motivate (for the empirical analysis) how existing FTAs influence the likelihood of subsequent FTAs. In order to "hold constant" as many effects as possible in our nonlinear model, we resume the assumption that all countries have identical absolute factor endowments, to eliminate asymmetries in economic size.

As suggested earlier, the two hypotheses are distinguished because one (*Hypothesis 4*) addresses the "competitive liberalization" hypothesis and the other (*Hypothesis 5*) addresses the "tariff-complementarity" hypothesis. Figures 4a and 4b illustrate the two hypotheses, *4* and *5*, respectively. Figure 4a illustrates the case of two countries, $1A$ and $1B$ – say, the US and Mexico – forming an FTA *conditioned upon* two other countries, $2A$ and $2B$ – say, France and Germany – already having an FTA. By contrast, Figure 4b illustrates the case of two countries, $1A$ and $1B$ – say, the US and Mexico – forming an FTA *conditioned upon* one of the countries (say, the US or $1A$) already having an agreement with another country (say, France or $2A$). It is important to note that – while countries $2A$ and $2B$ represent two countries on different continents – our framework allows inter- and intra-continental transport costs to vary between zero and prohibitive.

Hypothesis 4: The utility gain from (and likelihood of) an FTA between two countries

$1A$ and $1B$ increases due to an existing FTA between two *other* countries – on the same or different continents (i.e., competitive liberalization).

We consider first the case of two countries $1A$ and $1B$ forming a (natural) bilateral FTA; as before, we assume that all six countries initially have a tariff rate of 30 percent on each others' products.[16] We know from earlier comparative statics (Figure 1) that – conditioned upon no other FTAs in existence – such an FTA is necessarily welfare-improving. Figure 5a actually illustrates two surfaces. The bottom surface is the welfare gain for $1A$ of an FTA between countries $1A$ and $1B$ and no other FTA existing among all countries; we denote this $FTA_{1A,1B}$.

Suppose now instead that $2A$ and $2B$ already have an FTA. Figure 5a also illustrates the welfare gain to $1A$ of the formation of an FTA with $1B$ *conditioned on* an existing agreement between $2A$ and $2B$; this is the top surface. While the two surfaces are similar, the *existence* of $FTA_{2A,2B}$ increases unambiguously the gain in welfare of an FTA between $1A$ and $1B$. This is confirmed in Figure 5b which shows the (vertical) difference between the two surfaces, that is, the gains to $1A$ from an FTA between $1A$ and $1B$ conditioned on $FTA_{2A,2B}$ *less* the gains to $1A$ from $FTA_{1A,1B}$ without conditioning. Figure 5b reveals that the gain to $1A$'s utility of $FTA_{1A,1B}$ attributable to $FTA_{2A,2B}$ is positive for *all possible* intra- and inter-continental transports costs (from zero to prohibitive), given initial tariffs of 30 percent and $\sigma = 4$. This figure suggests that country $1A$'s "demand for membership" in an FTA with country $1B$ will tend to be higher if $2A$ and $2B$ have an *existing* FTA. The positive difference is the role of "third-country-pairs" creating *competitive liberalization*.[17]

Intuitively, when $2A$ and $2B$ form an FTA, each of $1A$ and $1B$ experience trade diversion, a loss of terms of trade, and erosion in real income. When a country pair $(2A, 2B)$ is remote – that is, when b is large – there are negligible volume-of-trade and terms-of-trade (real income) effects on $1A$'s utility from the formation of $FTA_{2A,2B}$ because there is little trade to be diverted between country $1A$ and countries $2A$ and $2B$. However, if inter- (and intra-) continental trade costs are low, then $1A$ trades considerably with $2A$ and $2B$; an FTA between $2A$ and $2B$ causes substantive trade diversion for $1A$, eroding $1A$'s volume of trade with $2A$ and $2B$ and $1A$'s utility and real income, but improving $1A$'s volume of trade with $1B$. Consequently, the formation of $FTA_{1A,1B}$ has an even larger impact on $1A$'s utility – in the presence of $FTA_{2A,2B}$

[16]In the next section's sensitivity analysis, we examine the robustness of these comparative statics to other initial tariff levels and to endogenous Nash equilibrium tariff setting.

[17]The comparative-static effect is qualitatively identical if the other FTA is between two countries on another continent $(3A, 3B)$.

than in its absence – because the elimination of tariffs from $FTA_{1A,1B}$ on the greater volume of trade between $1A$ and $1B$ due to $FTA_{2A,2B}$ more than offsets the terms-of-trade loss due to trade diversion from $FTA_{2A,2B}$. $FTA_{2A,2B}$ effectively has made countries $1A$ and $1B$ more "economically remote" and this isolation has made $1A$ and $1B$ economically more natural trade partners, enhancing the gains from an FTA.

We will discuss the sensitivity of the results to alternative values of σ, ϕ, and initial tariff rates later.

Hypothesis 5: The utility gain from (and likelihood of) an FTA between two countries $1A$ and $1B$ increases due to the existence of an FTA between either of these countries with *another* (third) country (i.e., tariff-complementarity), and the gain is likely larger than in the previous case.

Consider again the case of two countries $1A$ and $1B$ forming a (natural) bilateral FTA; as before, we assume initially that all six countries have a tariff rate of 30 percent on each others' products. Figure 6a illustrates two surfaces. The bottom surface is the welfare gain for $1A$ of an FTA between countries $1A$ and $1B$ and no other FTA existing among all countries, as in Figure 5a; we denote this $FTA_{1A,1B}$.

Suppose now instead that $1A$ and $2A$ already have an FTA. Figure 6a also illustrates the welfare gain to $1A$ of the formation of an FTA with $1B$ *conditioned on* an existing agreement between $1A$ and $2A$; this is the top surface in Figure 6a. While the two surfaces are similar, the *existence* of $FTA_{1A,2A}$ increases unambiguously the gain in welfare of an FTA between $1A$ and $1B$ – this is referred to in this paper as the "*own-FTA*" (or tariff-complementarity) effect. This is confirmed in Figure 6b which shows the (vertical) difference between the two surfaces, that is, the gains to $1A$ from an FTA between $1A$ and $1B$ conditioned on $FTA_{1A,2A}$ *less* the gains to $1A$ from $FTA_{1A,1B}$ without conditioning. Figure 6b reveals that the gain to 1A's utility of $FTA_{1A,1B}$ attributable to $FTA_{1A,2A}$ is positive for all possible intra- and inter-continental transports costs (from zero to prohibitive). This figure suggests that country $1A$'s "demand for membership" in an FTA with country $1B$ will tend to increase if $1A$ has an *existing* FTA with another country. Moreover, the effect is largest when trade costs are low. The economic intuition behind this is the following. At high trade costs, there is little trade between $1A$ and $2A$ so there can be little impact of $FTA_{1A,2A}$ on the gains to $1A$ from $FTA_{1A,1B}$. However, at low transport costs, $1A$ trades considerably with $2A$, and $FTA_{1A,2A}$ causes considerable trade diversion for $1A$ *with* $1B$, unlike the case of $FTA_{2A,2B}$ which increases $1A$'s trade with $1B$.

Two issues are worth noting. First, in contrast with the previous hypothesis, since $1A$ and $1B$ are trading less in the presence of $FTA_{1A,2A}$ than in its absence, this lower volume of trade erodes the relative gain to $1A$'s welfare of $FTA_{1A,1B}$. Second, one cannot ignore that $FTA_{1A,2A}$ increased the terms of trade and real income of country $1A$ (as well as that of $2A$). This improvement in terms of trade and real income has a positive benefit for improving $1A$'s utility gain from $FTA_{1A,1B}$, conditioned upon $FTA_{1A,2A}$.

We emphasize the relatively larger potential benefits from $FTA_{1A,1B}$ from the existence of $FTA_{1A,2A}$ (cf., Figure 6b) compared with the existence of $FTA_{2A,2B}$ (cf., Figure 5b) as measured by the percent change in utility. This is because $FTA_{1A,2A}$ causes a large increase in terms of trade and real income for $1A$ while $FTA_{2A,2B}$ causes a loss of terms of trade and real income for $1A$, even though $FTA_{1A,2A}$ leads to less trade volume between $1A$ and $1B$ and $FTA_{2A,2B}$ leads to more trade volume between $1A$ and $1B$. Hence, the percentage gain in utility for $1A$ from $FTA_{1A,1B}$ conditioned on $FTA_{1A,2A}$ is greater than that from $FTA_{1A,1B}$ conditioned on $FTA_{2A,2B}$. We will "test" this quantitative difference empirically later, using our qualitative choice econometric model.

Moreover, while $2A$ experiences some trade diversion with respect to $1B$ due to $FTA_{1A,1B}$, $2A$ still has an incentive to be in an FTA with $1A$. As Figure 6c reveals, $2A$ still experiences a utility gain from $FTA_{1A,2A}$ even conditioned on $FTA_{1A,1B}$. Thus, $2A$ has an incentive to be in an FTA with $1A$ even if it knew $1A$ would form an FTA with $1B$ at some point in the future.

Consequently, these comparative statics suggest that an increase in the number of FTAs that, say, country $1A$ has with other (non-$1B$) countries increases the likelihood of country $1A$ having an FTA with $1B$. In the next section, we discuss the robustness of these comparative statics.

3.4 Caveats

3.4.1 Sensitivity Analysis

Since our comparative statics are determined over the entire span of inter- and intra-continental trade costs from zero to prohibitive (i.e., $0 \leq a, b \leq 1$), the only other three parameters in our model influencing the comparative statics are the fixed cost parameter (ϕ), the elasticity of substitution in consumption (σ), and initial tariff rates (τ_{ij}). In our baseline model, we have assumed $\phi = 1$, $\sigma = 4$, and initially $\tau_{ij} = 0.3$, and then any bilateral FTA reduces τ from 0.3 to 0. We now consider the sensitivity of our comparative statics to variation in these values. For the impatient reader, the comparative statics discussed above are insensitive to the value of ϕ, but are sensitive to values of σ and initial levels of τ_{ij}.

First, consider the fixed cost parameter, ϕ, which was initially set arbitrarily equal to 1. It turns out the results are insensitive to variation in ϕ; it is an innocuous parameter. We re-ran the comparative statics using instead a value of $\phi = 10$, i.e., an order-of-magnitude change in the value of the parameter. The comparative statics were insensitive to this change.

Second, consider the elasticity of substitution, σ. Anderson and van Wincoop (2004) report a wide range of empirical estimates of σ. In general, they argue that a reasonable range of values of σ is between 5 and 10. However, some time-series analyses estimate σ lower than 5, and Krugman (1991a) suggested that a reasonable range is $2 < \sigma < 10$. Consequently, we re-ran our comparative statics for values of σ of 2 and 10 also. We found that Figures 5 and 6 were qualitatively identical for $\sigma = 10$. Own-FTA and third-country-pair FTA effects were both positive and the relative utility gain was higher for own-FTA effects (relative to third-country-pair-FTA effects); this suggests that the results are robust for $4 < \sigma < 10$. However, for $\sigma = 2$, the third-country-pair effect was negative; with a lower elasticity of substitution, the negative terms-of-trade effect from trade diversion offsets the positive volume-of-trade effect, so that "competitive liberalization" did not promote bilateralism. Since the own-FTA effect remained positive at $\sigma = 2$, the own-FTA effect still dominated the third-country-pair effect for promoting growth of bilateralism.

Third, consider the initial values of tariffs, $\tau_{ij} = 0.3$. The positive effects of own-FTAs and third-country-pair FTAs tend to be stronger the higher the initial values of τ, as for σ. At higher initial values of τ, the own-FTA and third-country-pair-FTA effects are positive at $\sigma = 4$. At τ initially equal to 0.4, the own-FTA and third-country-pair-FTA effects are both positive even at $\sigma = 2$. However, if $\tau = 0.15$ initially, both own-FTA and third-country-pair-FTA effects are negative. At lower initial values of τ, the terms-of-trade changes are not very large, dampening the net positive impacts.

However, one comparative static result is robust whenever the own-FTA and third-country-pair-FTA effects are positive. In such cases, the own-FTA effects (in terms of $1A$'s welfare) are *always larger* than the third-country-pair effects. This robust comparative static result suggests – when both factors have contributed to the growth of bilateralism – that the "tariff-complementarity" effect of one more existing FTA likely contributes more to the growth of bilateralism than the "competitive-liberalization" effect of one more existing third-country-pair FTA.

3.4.2 Regionalism

As stated at the outset, this paper's focus has been on explaining the growth of *bilateralism*, not regionalism. In reality, however, some country pairs that form FTAs are part of "enlargements," not stand-alone agreements. As this is not a focus of this paper and to limit the paper's scope, we choose not to offer a formal hypothesis for "testing." However, it is useful to consider the roles of "tariff complementarity" and "competitive liberalization" for enlargements.

In reality, we often observe enlargements of FTAs. Hence, we often observe $FTA_{1A,1B}$ *and* $FTA_{1A,2A}$ conditioned upon the existence of $FTA_{1B,2A}$, that is, enlargement of $FTA_{1B,2A}$ to include $1A$. For instance, the Canadian-US FTA was formed in 1989. In the early 1990s, Mexico wanted to form an FTA with the United States. However, the Canadian-US FTA was followed by NAFTA (Canada, Mexico, and US), rather than maintaining separate bilateral FTAs between Canada and the US and between Mexico and the US. Of course, expansion of the European Community/Union has been by enlargement.

We return to our baseline parameter values for σ, ϕ, and initial values of τ_{ij}. Consider instead the gain in utility to country $1A$ from an FTA with $1B$ *and* one with $2A$ *conditioned upon* an FTA already existing between $1B$ and $2A$, i.e., enlargement of $FTA_{1B,2A}$. It turns out (figures omitted for brevity) that $1A$'s utility actually declines from $FTA_{1B,2A}$ already being in place. The economic reason behind this is the following. The formation of $FTA_{1B,2A}$ causes a large amount of trade diversion for $1A$ at low transport costs. This has a very large negative impact upon its terms of trade, especially at low intra- and inter-continental transport costs, $\sigma = 4$, and initial tariffs of 0.3. However, as before at higher initial tariffs (say, 0.4), the net welfare gain to $1A$ of forming an FTA with $1B$ and with $2A$ – that is, enlargement – is enhanced by the existence of $FTA_{1B,2A}$. Hence, the demand for membership by $1A$ is enhanced by competitive liberalization if the decline in tariffs is sufficiently great and the elasticity of substitution is sufficiently high. Consequently, in the context of our model, Baldwin's "domino theory" does not *necessarily* hold; it depends on the values of σ and initial tariffs.

3.4.3 Other Caveats

Finally, we return to some of the caveats raised earlier regarding special interests and endogenous tariffs. Regarding special interests and political economy issues, we conjecture our model could be enhanced to account for an influence of special interests in the government's objective function. We have no reason to believe that the relative importance of these considerations would be any different in our model relative to other models, such as those in Ornelas (2005a,b,c). Extensions to incorporate considerations as raised in Ornelas (2005a,b,c) would be useful, but are beyond this paper's scope.

Second, we consider the importance of allowing for *endogenous* tariffs. As alluded to in an earlier footnote, we have been able to solve our model using endogenous (Nash equilibrium) tariffs. Because of the demanding computer requirements for solving our nonlinear, three-continent, six-country model using pre-FTA and post-FTA Nash equilibrium tariffs under a wide range of inter- and intra-continental transport costs, we do not provide an exhaustive robustness analysis. However, we have calculated some similar comparative statics using a three-country version of our model (countries 1, 2, 3) with symmetric endowments. Two main conclusions surface from this sensitivity analysis. First, using endogenous Nash equilibrium tariffs, the initial (endogenously-determined) tariffs for each of the three countries is approximately 0.4, assuming zero intra- and inter-continental trade costs and using the baseline values of $\sigma = 4$ and $\phi = 1$. Second, assuming (exogenously) an FTA between countries 1 and 2, we find in our model that the best-response tariff for country 1 (2) on goods imported from nonmember country 3 is always less than 0.2. Consequently, FTA members lower their external tariffs endogenously (although not to zero due to rebated tariff revenue). Moreover, the best response of country 3 is to maintain its tariff on goods imported from either country 1 or 2 at approximately 0.4. Hence, country 3 does not raise its optimal tariff. These results appear consistent with our earlier results. As stated earlier, since the primary focus of our study is a potential *empirical* contribution, our sensitivity analysis is limited.

In the next section, we use guidance from these comparative statics to postulate a logit model to examine each of these hypotheses and find evidence of "endogenous bilateralism" using multilateral FTA and ROW FTA indexes to capture the own-FTA and third-country-pair-FTA effects, respectively. However, we note now an important implication of the previous comparative statics that will influence measurement of these multilateral FTA indexes. Each comparative static of an FTA formation represented a discrete change of a country-pair's tariff from a positive value to 0. Thus, our multilateral indexes will need to be averages of these discrete changes; this will necessitate either a simple or weighted average. In anticipation of this, examination of any of Figures 5-6 suggests that the quantitative effect of an existing FTA on the welfare gain for a country from a subsequent FTA is sensitive to the level of intra- and inter-continental transport costs (which of course are related in reality to distance). One possibility is to weight other FTAs in the multilateral (and ROW) FTA indexes by inverse-distances (as has been done previously). We will address the issue in an alternative way later when we explore the estimated marginal response probabilities, distinguishing between natural (close) and unnatural (distant) FTA partners.

4 Econometric Issues and Data

4.1 Econometric Issues

The econometric framework employed is the qualitative choice model of McFadden (1975, 1976), as in B-B. A qualitative choice model can be derived from an underlying latent variable model. For instance, let $y*$ denote an unobserved (or latent) variable, where for simplicity we ignore the observation subscript. As in Wooldridge (2000), let $y*_{ijt}$ in the present context represent the percent difference in utility levels from an action (formation of an FTA) between countries i and j in year t, where:

$$y*_{ijt} = \alpha + x_{ijt}\beta + \epsilon_{ijt} \tag{9}$$

where α is a parameter, x_{ijt} is a vector of explanatory variables (i.e., economic characteristics), β is a vector of parameters, and error term ϵ_{ijt} is assumed to be independent of x_{ijt} and to have a logistic distribution; we will also consider in the sensitivity analysis the standard normal distribution for ϵ_{ijt}. In the context of our model formally, $y*_{ijt} = min(\Delta U_{it}, \Delta U_{jt})$ where ΔU_{it} (ΔU_{jt}) denotes the percent change in utility for the representative consumer in i (j) in year t. Hence, both countries' consumers need to benefit from an FTA for their governments to form one, as in B-B.

Since $y*_{ijt}$ is unobservable, following B-B we define an indicator variable, FTA_{ijt}, which assumes the value 1 if two countries have an FTA and 0 otherwise, with the response probability, Pr, for FTA:

$$Pr(FTA_{ijt} = 1) = Pr(y^*_{ijt} > 0) = G(\mathbf{x}_{ijt}\beta), \tag{10}$$

where $G(\cdot)$ is the logistic cumulative distribution function, ensuring that $Pr(FTA_{ij} = 1)$ is between 0 and 1.[18] While the statistical significance of the logit estimates can be determined using t-statistics, the coefficient estimates can only reveal the sign of the partial effects of changes in x on the probability of an FTA, due to the nonlinear nature of $G(\cdot)$. Drawing upon analogy to the labor literature, we assume the existence of a "reservation cost" to forming an FTA (denoted $y*^R$). Hence, the gain in utility from forming/joining an FTA must exceed this cost (e.g., political and/or administrative cost of action) in order for an FTA "event" to occur. If $y *_{ijt} - y*^R > 0$, then the FTA event for the pair of countries occurs at time t. Initially, we assume $y*^R$ is exogenous and constant; however, $y*^R$ may be time-varying, which we explore in the empirical sensitivity analysis using time dummies.[19]

4.2 Intuition for Multilateral FTA Terms

The theoretical comparative statics suggest that $\mathbf{x}_{ijt}$ should be influenced by the distance between countries i and j and their remoteness (Figure 1), the economic size and similarity of countries i and j (Figures 2 and 3), an index of all FTAs *other than* those with i or j (Figure 5), and "multilateral" indexes of each of i's and j's other FTAs (Figure 6). While measurement of distance, economic size, and economic similarity is straightforward, measurements of indexes of "multilateral FTAs" for i and j and an index of all other non-ij FTAs (henceforth, for tractability, termed ij's "*ROW* FTAs" index) are not readily observed. Our theoretical model suggests two alternative approaches, and we contrast their performances in the sensitivity analysis later. Moreover, measures of remoteness are not as obvious as those for distance; we address these in section 4.3.

Initially, we consider a multilateral index of country i's FTAs with every other (non-j) country. We consider the simplest approach, which is an unweighted sum of country i's indexes

[18] We will also consider probit estimates for robustness. However, as will be discussed later, logit is less restrictive (and problematic) than probit for introducing fixed effects in the robustness analysis.

[19] Since our empirical analysis addresses timing issues, an econometric duration analysis may also be suitable; we discuss the robustness of our results to this alterative approach in the sensitivity analysis later.

of FTAs with all other countries (excluding j) five years earlier $(t-5)$:

$$MFTA_{i,t-5} = \sum_{k \neq j}^{N} FTA_{ik,t-5} \tag{11}$$

where $FTA_{ik,t-5}$ is, as before, a binary variable assuming the value 1 if i and k have an FTA in year $t-5$, and 0 otherwise. We choose to use a "count" variable, rather than a simple average, because later we can then estimate the marginal response probabilities of *adding a single FTA*. We compute $MFTA$ lagged five years to avoid endogeneity bias. Analogously, we define for j:

$$MFTA_{j,t-5} = \sum_{k \neq i}^{N} FTA_{jk,t-5}. \tag{12}$$

It follows that we can define the index for all non-ij FTAs for country-pair ij, $ROWFTA_{ij,t-5}$, as:

$$ROWFTA_{ij,t-5} = \sum_{k \neq i}^{N} \sum_{l \neq j}^{N} FTA_{kl,t-5}. \tag{13}$$

Hypothesis 4 ("third-country-pair" effect) suggests that the coefficient estimate for $ROWFTA_{ij,t-5}$ should be positive (Figure 5). *Hypothesis 5* suggests that the coefficient estimates for $MFTA_{i,t-5}$ and $MFTA_{j,t-5}$ should be positive (Figure 6), and their marginal response probabilities larger than those for $ROWFTA_{ijt}$ (compare Figure 5b with Figure 6b).[20]

An alternative measure might recognize that each bilateral FTA component of these indexes should be weighted by its relative economic importance. We re-ran our numerical simulations for Figures 5 and 6 to allow countries $2A$ and $2B$ to have smaller absolute endowments (similar to asymmetries introduced for Figures 2 and 3). The simulations revealed that the effects shown in Figures 5 and 6 were diminished quantitatively when such countries had smaller economic sizes. For brevity, we do not provide these figures, but they are available on request. These results suggest alternative GDP-weighted multilateral and ROW indexes:

$$MFTAY_{i,t-5} = \sum_{k \neq j}^{N} Y_{k,t-5} FTA_{ik,t-5} \tag{14}$$

where $Y_{k,t-5}$ is country k's GDP in year $t-5$. We define $MFTAY_{j,t-5}$ and $ROWFTA_{ij,t-5}$

[20] As discussed earlier, caveats apply to the two hypotheses as suggested by the sensitivity analysis in section 3.

analogously. We apply this alternative weighting method in the sensitivity analysis.[21]

While the use of unweighted and GDP-weighted averages of each country's bilateral FTA indexes may seem simple, such quantitative multilateral indexes can be motivated formally using the linear-approximation approach of Baier and Bergstrand (2009) to the general equilibrium theoretical foundations for "multilateral resistance" terms developed in the gravity-equation theory in Anderson and van Wincoop (2003). Appendix A provides a summary of the Baier-Bergstrand method for approximating the Anderson-van Wincoop multilateral indexes of trade costs, and it is discussed briefly in the next section.

Finally, alternative weights that come to mind are bilateral-trade-share weights or factors that might influence bilateral trade shares, such as inverse-bilateral-distances or GDPs divided by bilateral distances. Baldwin and Jaimovich (2008) used bilateral trade shares, as did Egger and Larch (2008) in a sensitivity analysis of their spatial-lag construction. However, as both studies noted, such shares may create an endogeneity bias. Consequently, Egger and Larch (2008) relied upon inverse-distance weights in their construction of their primary spatial lags. However, as Figure 5b suggests, while the quantitative effects on welfare changes for country $1A$ of $FTA_{1A,1B}$ owing to existing agreements are unambiguously positively related to lower *intra*-continental transport costs (and likely lower intra-continental bilateral distance), such effects may be positively or negatively related to lower *inter*-continental transport costs (and likely lower inter-continental bilateral distance) *depending on* the level of inter-continental transport costs. Figure 5b hints at a possible quadratic relationship between the welfare effects and the level of inter-continental transport costs. Thus, scaling by inverse-distances may create problems. Nevertheless, we can examine the sensitivity of the results to the roles of inter- and intra-continental transport costs later when we estimate the marginal response probabilities separately for trading partners on the same or different continents.

4.3 Multilateral Resistance and Other Data Issues

Since Tinbergen (1962), gravity-equation analyses of bilateral trade flows have measured the presence or absence of an FTA between a country-pair using a binary variable. Following those

[21] Of course, GDPs increase over time and consequently not scaling GDPs of countries by world GDP may influence the results. Consequently, we also considered weights $\theta_{k,t-5} = Y_{k,t-5}/Y^W_{t,t-5}$, where Y^W_{t-5} is world GDP. The results are robust to this alternative measure. The alternative measure only influences the absolute magnitudes of the coefficient estimates, but has no bearing on the marginal response probabilities.

studies and B-B, variable FTA_{ijt} will have the value 1 for a pair of countries (i, j) with an FTA (specifically, FTA, customs union, common market, or economic union) in year t, and 0 otherwise; we exclude one-way and two-way "preferential" trade agreements (where "preferential" denotes only partial liberalization, not "free" trade). This variable was constructed using all bilateral pairings among 195 countries in the world annually from 1960-2005.[22] A decomposition of cells is provided in Table 1.

The only other data needed are real GDPs, bilateral distances, a dummy variable assuming the value 1 (0) if two countries are on the same continent ($CONT_{ij}$), and indexes of "remoteness." In order to employ a consistent real GDP data set for such a long period, we use real GDP data from Maddison (2009). However, the cost of a consistent real GDP panel data set for such a long time period is number of usable countries. This lowers the number of countries from 195 to 146, and the consequent loss of observations. We construct for every country-pair the variable $SUMGDP_{ij,t-5}$, which is the natural log of the sum of i's and j's real GDPs five years prior to year t. We measure the dissimilarity of economic sizes using $DIFGDP_{ij,t-5}$, which is the absolute value of the difference in the log of each country's real GDP. Bilateral distances are calculated from great-circle distances using latitudes and longitudes between economic centers from the CIA's $WorldFactbook$, as is standard. $DIST_{ij}$ refers to the natural logarithm of the bilateral distance between the two countries i and j. However, measures of "remoteness" of a country-pair are not readily observable. We now address this issue briefly.

Recent studies by Egger and Larch (2008) and Baldwin and Jaimovich (2008) have followed B-B and used a simple average of the logarithms of the simple averages of each of countries i's and j's bilateral distances to all other countries to measure a pair of countries' "remoteness," cf., B-B (2004, p. 40). This variable typically has a positive coefficient estimate sign and statistical significance. However, there is no explicit theoretical foundation for its formulation. It turns out that a formulation very close to this surfaces from recent developments in the theoretical foundations for the gravity equation. These recent developments – based upon Anderson and van Wincoop (2003), as modified using a Taylor-series expansion in Baier and Bergstrand (2009) – provide guidance for measuring remoteness using "multilateral resistance"

[22] The data base is available at www.nd.edu/ jbergstr. Documentation for its construction is provided at the website. Every positive cell entry is hyper-linked to a PDF of its original treaty (98 percent of cells) or a secondary source (2 percent of cells); not all cells are potential observations as over the period some countries formed and others dissolved, e.g, Czechoslovakia. We will use only 146 of these countries as will be explained shortly.

indexes that are very similar to equations (11)-(13) for FTAs. For instance, for country i's multilateral resistance index for the log of distance we use either:

$$MDIST_i = \frac{1}{N}\sum_{k}^{N} DIST_{ik} \tag{15}$$

or

$$MDISTY_{it} = \sum_{k}^{N} \theta_{kt} DIST_{ik} \tag{16}$$

where $\theta_{kt} = Y_{kt}/Y_t^W$. Analogous terms apply for $MDIST_j$ and $MDISTY_{jt}$.[23] Similarly, for country i's multilateral resistance index for the binary variable $CONT_{ij}$ we define:

$$MCONT_i = \frac{1}{N}\sum_{k}^{N} CONT_{ik} \tag{17}$$

or

$$MCONTY_{it} = \sum_{k}^{N} \theta_{kt} CONT_{ik} \tag{18}$$

and the analogous terms for $MCONT_j$ and $MCONTY_{jt}$. For parsimony, in the spirit of Baier and Bergstrand (2009), we condense these multilateral resistance terms into two variables for each country-pair. For constructing the "multilateral resistance" term for distance for the unweighted case, we have:

$$MDIST_{ij} = \frac{1}{2N}(\sum_{k=1}^{N} DIST_{ik} + \sum_{k=1}^{N} DIST_{jk}) \tag{19}$$

and analogously for the GDP-share-weighted case. For $CONT$, we use:

$$MCONT_{ij} = \frac{1}{2N}(\sum_{k=1}^{N} CONT_{ik} + \sum_{k=1}^{N} CONT_{jk}). \tag{20}$$

and analogously for the GDP-shared-weighted case (allowing for time variation in the GDP weights). See Appendix A for formal details of these variables' motivations.

[23] In the cases of these variables, we use averages rather than "count" variables, for convenience; this has no material consequence for the results.

5 Empirical Results

In this section, we first discuss the main empirical results. In the second part of this section, we discuss the results from a sensitivity analysis.

5.1 Main Results

Table 2 provides the main empirical results. Specification 1 provides the results for addressing *Hypothesis 1*, where the RHS variables are – in the case of unweighted averages – time-invariant variables. Specification 1 shows that $DIST_{ij}$, $CONT_{ij}$, and $MCONT_{ij}$ all have the expected signs and are statistically significant at conventional significance levels (1 percent). Bilateral distance has a negative effect on the probability of an FTA, while being on the same continent has a positive effect; these results are in line with the cross-sectional findings in B-B and *Hypothesis 1.* $MDIST_{ij}$ and $MCONT_{ij}$ both have negative effects on the likelihood of an FTA. While the coefficient estimate for $MCONT_{ij}$ is as expected, that for $MDIST_{ij}$ is the opposite of our expectation, since this is effectively a measure of "remoteness." However, we will see shortly that this unexpected negative coefficient sign is reversed in a fuller specification. The pseudo-R^2 is 0.39. Recall that in logit (or probit) regressions the coefficient signs are meaningful, but the actual values of the coefficients are not directly interpretable; however, marginal response probabilities will be calculated later, as in B-B, to examine the quantitative effects of one-standard-deviation changes in RHS variables (and for count variables, unit changes in the RHS variable).

Specification 2 in Table 2 augments Specification 1 to include the (5-year-lagged) logarithm of the joint economic size of countries i and j ($SUMGDP_{ij,t-5}$) and our measure of dissimilarity of economic sizes of i and j ($DIFGDP_{ij,t-5}$). We find that country-pairs are more likely to form an FTA the larger and more similar are their GDPs, in accordance with *Hypotheses 2* and *3*, respectively. The results in Specification 2 confirm using a very large pooled cross-section time-series data set the results found for a single cross-section of a smaller number of countries in B-B and are consistent with the pooled cross-section time-series results in Egger and Larch (2008).[24]

[24] We also used $ln[(Y_{it} + Y_{jt})/Y_t^W]$ for economic size, since world GDP changes over time; the results are robust to this alternative measure. Also, as in B-B and Egger and Larch (2008), we are using real GDPs as a proxy for absolute factor endowments. Consequently, the terms-of-trade (real income) effects effects from, say, a natural FTA relative to an unnatural FTA are captured by $DIST_{ij}$ and $CONT_{ij}$.

We now address *Hypotheses 4* and *5*. Specification 3 provides the results of augmenting Specification 2 with $MFTA_{i,t-5}$, $MFTA_{j,t-5}$, and $ROWFTA_{ij,t-5}$. Specification 3 is our main specification. First, all three of these variables have statistically significant positive coefficient estimates and the coefficient estimates of the other RHS variables retain their same signs and remain statistically significant except $MDIST_{ij}$, which reverses its sign to the expected positive one and is statistically significant. Second, the positive coefficient estimates for $MFTA_{i,t-5}$, $MFTA_{j,t-5}$, and $ROWFTA_{ij,t-5}$ all confirm *Hypotheses 4* and *5*. Third, the pseudo-R^2 of the logit regression is 0.56, which is substantive and very close to the pseudo-R^2 found in B-B for their much smaller and select cross-section sample for the year 1996. We note that there are 10,478 observations with FTAs ($FTA_{ij,t}$=1) in the sample of 358,767 observations spanning 1960-2005. Finally, we note that the coefficient estimates for $MFTA_{i,t-5}$ and $MFTA_{j,t-5}$ are substantively larger than that for $ROWFTA_{ij,t-5}$. The relatively larger coefficient estimates for the former variables are (seemingly) consistent with the relative quantitative predictions for the relative utility gains. However, because of the non-linearities using logit regressions, we will delay full discussion of these relative quantitative predictions until we examine more appropriately marginal response probabilities later.

5.2 Sensitivity Analysis

Specification 3 provides the main specification for predicting later the rate of "true positives" (predicting an FTA when one exists) and the rate of "true negatives" ("No-FTA" when none exists). In this sensitivity analysis, we examine the robustness of results using Specification 3 to examining "formations" of FTAs (rather than the indicator representing "existence" of an FTA in a given year), to using probit rather than logit estimation, to using alternative weights for the various multilateral and *ROW* index variables, to using a panel of every five years (rather than annual), to using instead a duration model, to the presence of country-pair fixed effects, and to inclusion of time dummies in addition to country-pair fixed effects. Finally, we report marginal response probabilities for Specification 3.

First, one concern of Specification 3 is that we are examining the "existences" of FTAs in a given year rather than their "formations." $FTA_{ij,t}$ assumes the value 1 if an FTA *exists* between i and j in any year t, and 0 otherwise. Alternatively, we would like to consider another dummy variable for the LHS that assumes the value 1 in a year t when an FTA is *formed* between i and

j in that year and 0 otherwise. Consequently, we construct a new variable, $TFTA_{ij,t}$, which assumes the value 1 if countries i and j *entered into* an FTA in year t, and 0 otherwise. As a result, the number of observations with FTA formations ($TFTA_{ij,t} = 1$) is 3,811, approximately one-third that for $FTA_{ij,t} = 1$. Specification 4 reports the results of replacing $FTA_{ij,t}$ with the "transition-to-FTA" binary variable $TFTA_{ij,t}$. We note that the number of total observations falls from 358,767 to 352,002 as we redefine the LHS dummy variable to represent the *change* from one year to the next in the FTA "status" of the pair. Note that the coefficient estimates in Specification 4 are qualitatively identical to those in Specification 3, with the exception of $MDIST_{ij}$ which has a negative effect now. Most importantly though, all the main results hold up; $MFTA_{i,t-5}$, $MFTA_{j,t-5}$, and $ROWFTA_{ij,t-5}$ all have positive and statistically significant coefficient estimates as expected. However, predicting transitions is more challenging than predicting the existence of FTAs; the pseudo-R^2 is lower at 0.34 compared with 0.56 for Specification 3, as expected.[25]

Second, both B-B and Egger and Larch (2008) used probit estimation rather than logit, the latter used here. Recall that our reason for using logit is that we will include country-pair fixed effects shortly. As clarified in Wooldridge (2002), since the logistic transformation is a linear one standard fixed effects can be readily applied without restrictions; by contrast, fixed effects have more restrictions on their implementation due to the Chamberlain (1980) "incidental parameters" issue. However, it is useful to show that the results are robust to estimation using probit. Specification 5 provides the results of re-estimating the model of determinants of existence of an FTA ($FTA_{ij,t}$) using probit. The results in Specification 5 are qualitatively identical to the corresponding logit ones in Specification 3 with one exception; the coefficient estimate for $MDIST_{ij}$ reverses signs from positive (which is expected) to negative but statistically insignificant in the probit specification. The pseudo-R^2 is 0.57. Quantitatively, with the exception of that for $MDIST_{ij}$ all the probit coefficient estimates are approximately 1/2 of those in the logit equation. Thus, the results are largely robust to estimation using probit instead.[26]

Third, as discussed earlier, our theoretical model provides no clear guidance for weights for the multilateral FTA indexes. Following guidance from recent theoretical developments for the

[25] A similar fall in overall explanatory power for the same adjustment was found in Egger and Larch (2008).

[26] We also ran the probit on the FTA transitions dummy ($TFTA_{ij,t}$) and the coefficient estimates are qualitatively identical to those using the corresponding logit specification, but not reported for brevity.

gravity equation in Anderson and van Wincoop (2003) as modified by Baier and Bergstrand (2009), the two weighting methods suggested are a simple average of components or a GDP-weighted average of bilateral components. We re-estimated our main logit specification (3) using GDP-weighted values of $MFTA_{i,t-5}$, $MFTA_{j,t-5}$, $ROWFTA_{ij,t-5}$, $MDIST_{ij}$, and $MCONT_{ij}$. The results are provided in Specification 6 for the existence of FTAs.[27] The results in Specification 3 are robust to using the GDP-weighted (or GDP-*share*-weighted) alternative variables; all coefficient estimates are qualitatively identical to those in Specification 6.[28]

Fourth, in the specifications used so far, we use five-year lagged values of $SUMGDP_{ij,t-5}$, $DIFGDP_{ij,t-5}$, $MFTA_{i,t-5}$, $MFTA_{j,t-5}$, and $ROWFTA_{ij,t-5}$ to predict the existence of (or transition to) an FTA for a country pair *within* the next five years. However, this large window for FTA predictions may introduce an endogeneity bias. Consequently, we re-estimated the main specification using only RHS and LHS variables with a sub-sample of *every five years*. This reduced our sample size for predicting existence from 358,767 to 77,059. The results are provided in Specification 7. We see in column (7) that all of the coefficient estimates are robust to this alternative specification which retains the 5-year lag for the RHS variables. The results for transition-to-FTA are also robust, but omitted from the table for brevity.

Fifth, Bergstrand, Egger, and Larch (2009) implemented instead a "duration analysis" of the likelihood of FTA events. Like logit and probit regressions, duration models fall within the class of "limited dependent variable" models, cf., Wooldridge (2002). These models estimate the "hazard rate," which is the instantaneous probability of leaving an initial state (No-FTA) in the interval $[t, t + dt)$ *given survival up until time t*. We also estimated a duration model using the same variables; the results are in Specification 8 (9) for existence of (transition to) FTAs. Columns (8) and (9) indicate that our main results from Specification 3 are robust qualitatively to using a duration model rather than a simple logit (or probit) model. All coefficient estimates (except, as before, that for $MDIST_{ij}$) are correctly signed and statistically significant.

Sixth, the results may be sensitive to omitted unobserved cross-sectional heterogeneity. As is often done in gravity equation analyses of trade flows, one introduces country-pair fixed effects to account for unobserved heterogeneity to ensure unbiased coefficient estimates. As

[27] Since Specification 6 is the only one in Table 2 to use the GDP-weighted versions of $MFTA_{i,t-5}, MFTA_{j,t-5}, ROWFTA_{ij,t-5}, MDIST_{ij,t-5}$ and $MCONT_{ij,t-5}$, we do not change the names of the variables named in column (1) to keep Table 2's size manageable.

[28] This conclusion also holds for the FTA transitions LHS variable ($TFTA_{ij,t}$). Using GDP weights causes $MDIST_{ij}$ and $MCONT_{ij}$ to become time-varying.

noted earlier, one of the advantages of logit over probit estimation (or duration analysis) is the ability to use standard fixed effects; by contrast, such effects cannot be used in probit specifications due to the normal distribution underlying probits.[29] Of course, the introduction of country-pair fixed effects implies removing all time-invariant variables, i.e., $DIST_{ij}$, $CONT_{ij}$, $MDIST_{ij}$, and $MCONT_{ij}$. Specification 10 reports the results of introducing country-pair fixed effects into main Specification 3. We see that the remaining time-varying variables' coefficient estimates are significant, with only the estimate for our measure of size-dissimilarity having an unexpected positive sign but statistical insignificance. All the other four variables' coefficient estimates retain the same expected positive signs as in previous regressions. When we introduce the same fixed effects into the logit regressions using "transition-to-FTA" binary variable $TFTA_{ij,t}$, shown in Specification 11, the coefficient estimates remain positive and statistically significant with the exception again of insignificance for the coefficient estimate for the GDP-size-dissimilarity variable.

Seventh, while the country-pair fixed effects specifications controlled for unobservable time-invariant factors, they did not control for unobservable time-varying factors. For instance, world GDP and technology change over time. More specific to the issues at hand, global liberalization of trade under the GATT/WTO may have had an influence on the likelihood of bilateralism being captured in the remaining time-varying RHS variables $SUMGDP_{ij,t-5}$, $DIFGDP_{ij,t-5}$, $MFTA_{i,t-5}$, $MFTA_{j,t-5}$, and $ROWFTA_{ij,t-5}$. Specifications 12 and 13 add to the logit fixed-effects specifications 10 and 11, respectively, time dummies. Columns (12) and (13) report the results for the existence-of-FTA and transition-to-FTA specifications, respectively. In Specification 12 the $SUMGDP_{ij,t-5}$ ($DIFGDP_{ij,t-5}$) coefficient estimate retains the expected positive (negative) sign and is statistically significant (insignificant). Moreover, the coefficient estimates for $MFTA_{i,t-5}$, $MFTA_{j,t-5}$, and $ROWFTA_{ij,t-5}$ are positively signed as expected and remain statistically significant. In Specification 13, the $SUMGDP_{ij,t-5}$ and $DIFGDP_{ij,t-5}$ coefficient estimates have the expected signs and both are statistically significant. The coefficient estimates for $MFTA_{i,t-5}$ and $MFTA_{j,t-5}$ remain positively signed and statistically significant. The coefficient estimate for $ROWFTA_{ij,t-5}$ is positively signed, but statistically insignificant. These results confirm the importance of existing FTAs for enhancing the likelihood of subsequent FTAs.

[29] There are some "restricted" methods though to try to circumvent these issues; see Chamberlain (1980) for methodology.

Table 3 reports the marginal response probabilities, calculated at the means of the levels of all variables. We follow the approach used in Baier and Bergstrand (2004) by separating the marginal response probabilities into those calculated for "natural" trading partners (i.e., pairs on the same continent) and those for "unnatural" trading partners (i.e., pairs on different continents). There are two reasons for this here. First, as in B-B, it makes little economic sense to evaluate the marginal response probabilities at the "mean" of a binary variable representing the presence or absence of being on the same continent. Second, our comparative static theoretical results suggest that the utility gains for a country-pair from forming an FTA are sensitive to the level of transportation costs. One transparent method for evaluating the influence of distance on the effects of existing FTAs on the likelihood of subsequent FTAs is to evaluate marginal response probabilities *separately* for natural and unnatural trading partners. The format of this table is the same as in B-B.

Table 3a reports the marginal response probabilities for natural trading partners. First, for ease of reference the probability of an FTA among natural partners at the mean level of all (other) RHS variables is 0.1031, with a 95 percent confidence interval of 0.0995 to 0.1068. We now consider the effect of a one standard deviation (S.D.) increase or decrease of variables. The sixth (seventh) line of Table 3a indicates that a one S.D. increase in $MFTA_{i,t-5}$ ($MFTA_{j,t-5}$) increases the probability of $FTA_{ij,t}$ to 0.1306 (0.1381). Each of these probability changes is statistically significant at the 95 percent level, but not significantly different from one another.[30] By contrast, a one S.D. increase in $ROWFTA_{ij,t-5}$ increases the probability of $FTA_{ij,t}$ to only 0.1101, which is also a statistically significant change. The difference in the marginal response probabilities for $MFTA_{i,t-5}$ ($MFTA_{j,t-5}$) and $ROWFTA_{ij,t-5}$ is economically and statistically significant. Moreover, the difference in such probabilities is as expected; a one S.D. change in $MFTA_{i,t-5}$ ($MFTA_{j,t-5}$) has a quantitatively larger impact on the likelihood of $FTA_{ij,t}$ than does a one S.D. change in $ROWFTA_{ij,t-5}$. These quantitative results are consistent with relative quantitative welfare effects described by Figures 5b and 6b. *These results suggest that "tariff complementarity" has an economically and statistically larger effect on the growth of bilateralism than "competitive liberalization."*

Yet, a one standard deviation change in $MFTA_{i,t-5}$ (or $MFTA_{j,t-5}$) need not be the same

[30]Note that each country pair enters the data set only *once*, unlike gross trade flows in gravity equations. Thus, the coefficients on $MFTA_{i,t-5}$ and $MFTA_{j,t-5}$ need not be exactly equal; if every pair entered twice, they would be exactly equal.

as a one standard deviation change in $ROWFTA_{ij,t-5}$, potentially challenging the conclusion above. Consequently, the last three rows of Table 3a report the marginal response probabilities of a *one-unit increase* in $MFTA_{i,t-5}$, a *one-unit increase* in $MFTA_{j,t-5}$, and a *two-unit increase* for $ROWFTA_{ij,t-5}$. Note that a one-unit – or *one-FTA* – increase in $MFTA_{i,t-5}$ ($MFTA_{j,t-5}$) increases the probability of $FTA_{ij,t}$ by 0.44 (0.54) percentage point, and the effect is economically and statistically significant. However, a two-unit increase in $ROW_{ij,t-5}$ increases the probability of $FTA_{ij,t}$ by only 0.01 percentage point, which is neither economically nor statistically significant.[31] Consequently, using this alternative increase, our conclusion above that tariff-complementarity has an economically and statistically larger effect on the growth of bilateralism than competitive liberalization is supported.[32]

Table 3b reports the marginal response probabilities for unnatural trading partners (i.e., pairs on different continents). The probability of an FTA among unnatural trading partners at the mean level of all (other) RHS variables is 0.0066, with a 95 percent confidence interval of 0.0061 to 0.0071. The sixth (seventh) line of Table 3b indicates that a one S.D. increase in $MFTA_{i,t-5}$ ($MFTA_{j,t-5}$) increases the probability of $FTA_{ij,t}$ to 0.0103 (0.0115). Each of these probability changes is statistically significant at the 95 percent level, but not significantly different from one another. By contrast, a one S.D. increase in $ROWFTA_{ij,t-5}$ increases the probability of $FTA_{ij,t}$ to 0.0075, which is not a statistically significant change. The difference in the marginal response probabilities for $MFTA_{i,t-5}$ ($MFTA_{j,t-5}$) and $ROWFTA_{ij,t-5}$ is economically and statistically significant. Moreover, the difference in such probabilities is as expected; a one S.D. change in $MFTA_{i,t-5}$ ($MFTA_{j,t-5}$) has a quantitatively larger impact on the likelihood of $FTA_{ij,t}$ than does a one S.D. change in $ROWFTA_{ij,t-5}$. For brevity, we do not review the other marginal response probabilities. However, all such probabilities change in the expected directions and all such changes are statistically significant except for $MCONT_{ij}$. These quantitative results are consistent with relative quantitative welfare effects described by Figures 5b and 6b. These results also suggest that "tariff complementarity" has an economically and statistically larger effect on the growth of bilateralism than "competitive liberalization."

[31] In the context of *Hypothesis 4*, conditioning on $FTA_{1A,2A}$ is equivalent to a one-unit increase whereas – in the context of *Hypothesis 5* – conditioning on $FTA_{2A,2B}$ is equivalent to a two-unit increase.

[32] Note, however, that our marginal response probabilities – calculated using either a one-standard-deviation or a one-unit change – are employed to evaluate empirically (as closely as feasible) our theoretical *Hypotheses 4* and *5*. However, one could argue that the number of *third-country-pair* FTAs that a typical country-pair faces combined with the $ROWFTA_{ij,t-5}$ marginal response probability should be compared with the number of *own* FTAs combined with the $MFTA_{i,t-5}$ marginal response probability. We leave this to future research.

Finally, we note that the change in the probability of FTA_{ijt} due to an increase in $MFTA_{i,t-5}$ (or $MFTA_{j,t-5}$ or $ROWFTA_{ij,t-5}$) is much higher for natural trading partners than for unnatural trading partners, as our comparative statics in section 3 suggested. For instance, for $MFTA_{i,t-5}$ a one unit increase in this variable (that is, one more bilateral FTA for i) causes a 0.44 percent (0.05 percent) increase in the likelihood of FTA_{ij} within the next five years if i and j are on the same (a different) continent.

6 Predicting FTAs

An alternative measure of goodness-of-fit for logit and probit models is the "percent correctly predicted." However, Wooldridge (2000) points out that this percent may be misleading. For instance, in Baier and Bergstrand (2004), the authors had a sample of 1431 country pairs for the year 1996 with 286 actual FTAs (true positives, or TPs). Hence, 20 percent of the observations were FTAs. The "unconditional" probability of an FTA was 20 percent and the unconditional probability of No-FTA was 80 percent (1145/1431). Consequently, even if the model had no explanatory power and failed to predict correctly even one FTA, the percent of No-FTAs correctly predicted is almost *80 percent*. This large percentage misrepresents the zero predictive power of the model for predicting true positives.

Wooldridge (2000) recommends examining separately the percent correctly predicted *for each of the two outcomes*. That is, the percent of "true positives" (TPs) in "all positives" (APs), or TPs/APs = TPs/(TPs+FPs) where FP denotes "false positives," is important, but so is the percent of "true negatives" (TNs) in "all negatives" (ANs), or TNs/ANs = TNs/(TNs+FNs) where FN denotes "false negative." Baier and Bergstrand (2004) conducted this statistical summary for their cross-section analysis of year 1996 data and found that their model predicted correctly 243 of 286 FTAs, or 84.97 percent. They also predicted 1,114 of the 1,145 pairs without FTAs correctly, or 97.29 percent.

However, a *critical* issue in classification is the choice of the "cutoff" on the probability continuum. Baier and Bergstrand (2004) and Egger and Larch (2008) followed McFadden (1975, 1976) in using a probability cutoff (p^C) of 0.5 to determine if an FTA was predicted or not. Letting p_{ij} denote the predicted probability from the probit regression in B-B, if $p_{ij} > 0.5$ and the country-pair ij had an FTA, this would be a true positive. If $p_{ij} \leq 0.5$ and ij did not have an FTA, this would be a true negative.

In the this part, we examine some summary statistics associated with alternative cutoff probabilities. We examine five alternative methods for assessing the overall predictive power of our main logit models for existence of and transition to FTAs, which are Specifications 3 and 4, respectively. The first concerns establishing a cutoff probability based upon maximizing the overall predictive power; this is determined by a "Specificity-Sensitivity" analysis, described shortly. The second and third concern establishing cutoff probabilities consistent with having a TN rate *no lower* than that in B-B (97 percent) or Egger and Larch (2008) (99 percent), respectively. The fourth uses the arbitrary cutoff of 0.5, but it turns out that this cutoff is consistent with a true negative rate of 99 percent (as in the third approach). The fifth uses the notion of Reciprocal Operating Characteristic (ROC) curves, which will be discussed.

While B-B and Egger and Larch (2008) used a p^C of 0.5, we believe this cutoff is not a very relevant one. The reason lies in the fact that – as noted earlier – bilateral FTA events in our panel of over 350,000 observations are rare events. First, the number of observations when an FTA *exists* between a country-pair in a given year is 10,478; this is only 3 percent of all observations. Second, the number of observations when a country-pair *forms* (or transitions to) an FTA is 3,811; this is only 1 percent of all observations. Figure 7a provides a plot of the frequency of the predicted probability of an FTA (p_{ijt}) using Specification 3; this confirms visually that FTAs are rare events and that a $p_{ijt} > 0.5$ would be an extremely rare event. Consequently, we ignore this cutoff for now, although for completeness we will report the TP and TN rates for $p^C = 0.5$ later.

Cohen et al. (2003) suggests using *a priori* information about the proportion of FTA events and No-FTA events in our population. Consider first the case of FTA existences. The proportion of FTAs (No-FTAs) in our panel – which is virtually the entire population of country-pairs since 1960 – is 3 percent (97 percent). Hence, the unconditional probability of an FTA existing between any country-pair in a given year is 3 percent. This suggests a more appropriate cutoff probability is 0.03. In fact, it turns out that the TP and TN rates are maximized at this cutoff, as we now show.

Naturally, one wants to maximize both the rates of true positives (TPs) and true negatives (TNs). However, there is a trade-off. Figure 7b graphs the TP and TN rates for Specification 3 (logit, FTA existence) against the entire range of possible cutoff probabilities; Figure 7c graphs the TP and TN rates against the same range of p^C for Specification 4 (logit, FTA transition). One can see from Figure 7b that at p^C of near 0, one maximizes the likelihood of predicting an FTA when one exists; however, the TN rate is virtually zero, which is a severe problem since the vast bulk of observations is zero. To increase the TN rate, a higher p^C is needed. For our first approach, it turns out that at a p^C of 0.03 (specifically, 0.0328) we maximize both the the TP and TN rates at 91 percent. Thus, at a cutoff probability consistent with the unconditional probability of an FTA existing (0.03), the model predicts correctly 91 percent of the cases when an FTA exists within five years of the agreement forming and 91 percent of the cases when No-FTA is correct. We have also conducted this analysis for predicting formations of FTA ($TFTA_{ijt}$ equals 1 in the year an FTA goes into force, and 0 otherwise). In this case, the model predicts correctly 89 percent of the true positives within five years of the formation and 89 percent of the TNs, as shown in Figure 7c.

Our second and third approaches consider two other possible cutoff probabilities. In the first approach, we obtain a success rate for predicting FTAs when FTAs exist of 91 percent (the TP rate). And while the TN rate may seem high at 91 percent, we still have a false positive rate of 9 percent, which implies in our sample of over 350,000 observations that we incorrectly predict FTA when No-FTA exists in 9 percent of the cases. However, B-B had a higher TN rate of 97 percent (owing to its $p^C = 0.5$) and Egger and Larch (2008) had a TN rate of 99 percent (also using a $p^C = 0.5$), implying much stricter false positive rates of 3 and 1 percent, respectively. As Figure 7b suggests, one can raise the p^C to ensure a higher TN rate, to be consistent with these studies, which will of course lower the TP rate. We considered two alternative values of p^C. First, we considered $p^C = 0.114$, which ensured a TN rate of 97 percent as in B-B. The associated TP rate was 75 percent. The latter value is only 10 percent less than the 85 percent TP rate in B-B for only a cross-section of bilateral FTAs among 53 country-pairs. Our TP rate of 75 percent is remarkably high considering we are predicting the existence of an FTA between a country-pair within *only five years* of its formation. For a TN rate of 99 percent (implying $p^C = 0.307$), the TP rate for existence of an FTA between a country-pair within five years of its formation falls to 48 percent. We also considered the TP rates for predicting the actual year of *formation* (date of entry) of an FTA between a country-pair within five years of its actual formation. At a TN rate of 97 percent, the TP rate is 56 percent. At a TN rate of 99 percent, the TP rate is 26 percent. Our fourth approach simply uses the cutoff probability of 0.5.

Tables 4a and 4b summarize the information above and additionally provide information about the TP and TN rates by individual year as well as with and without the $MFTA_{i,t-5}$, $MFTA_{j,t-5}$, and $ROWFTA_{ij,t-5}$ terms. For economy, we provide the predictions at 5-year intervals as well as over all the years, where the logit specification in Table 4a includes the $MFTA$ and $ROWFTA$ terms and the specification in Table 4b *excludes* these terms. First, in the second and third columns, we use the cutoff that maximizes overall success rate using a Sensitivity-Specificity analysis, that is, maximizing both the TP and TN rates. For FTA existences including *MFTA* and *ROWFTA*, this is 91.04 percent in Table 4a. In Table 4b, we can see from columns 2 and 3 that the percent correctly predicted without *MFTA* and $ROWFTA$ is 88.35 percent. However, returning to Table 4a, this 91 percent still leaves 9 percent of the observations false negatives. The second approach considered a cutoff no lower than that in Baier and Bergstrand (2004), 97 percent. With a higher TN rate, the fourth and fifth columns report a lower TP rate of 75.50 (65.34) percent in the specification with (without) the $MFTA$ and $ROWFTA$ terms. In our third approach with a TN rate of 99 percent as in Egger and Larch (2008), the TP rate falls to 47.67 (32.37) percent in the specification with (without) the $MFTA$ and $ROWFTA$ terms. Fourth, the eighth and ninth columns provide the TP rates using a cutoff of $p^C = 0.5$. The TP rate is 47.07 percent, which is similar to that using the 99 percent TN rate in the third approach. However, by contrast with the logit specification omitting the $MFTA$ and $ROWFTA$ terms, the predictive power of this logit is better; in Table 4b we predict only 28.31 percent of the FTA cells correctly using a cutoff of 0.5.[33] One more interesting result is worth noting from a comparison of Tables 4a and 4b. In the case of Table 4a, the presence of the $MFTA$ and $ROWFTA$ terms in the specification causes the percent correctly predicted to increase as time progresses; however, in the case of Table 4b, the percent correctly predicted falls over time. Hence, accounting for endogenous bilateralism in the logit specification contributes to a relatively more successful true positive rate over time.

Finally, the literature on Receiver Operating Characteristics (ROC) often measures the overall fit of a model by examining the area underneath the "ROC" curve, cf., Fawcett (2006). In our fifth approach, a ROC curve graphs the TP rate against the false positive (FP) rate, which is one minus the TN rate. Thus, the fit of a model is perfect when the area under the curve fills completely the upper-left triangle of Figure 8 (i.e., the TP rate is 1 and the FP

[33] The near doubling in predictive TP rates is much larger than the 5 percentage point improvement in Egger and Larch (2008) from introducing their spatial lag.

rate is 0). Figures 8a and 8b provide the ROC curves for the cases of existence of FTAs and transitions to FTAs, respectively. In the case of existences of FTAs, the area underneath the ROC curve is 97 percent. In the case of transitions to FTAs, the area underneath the ROC curve is 95 percent. Thus, the models provide excellent fits in both cases.

7 Conclusions

One of the most notable international economic events of the past 20 years has been the proliferation of bilateral FTAs, argued by some to be attributable to governments having pursued a policy of "competitive liberalization." We have employed new comparative statics from a simplified version of the numerical general equilibrium model of FTA economic determinants in Baier and Bergstrand (2004) to suggest how the net welfare gains of an FTA between country i and country j would be influenced by other FTAs – both those of i (or j) with other countries – due to "tariff complementarity" – as well as those among other countries (say, k with l) – due to competitive liberalization. Guided by these general equilibrium comparative statics, we specified a simple logit (and probit) model to estimate the influence on the likelihood of a bilateral FTA between i and j of indexes for each country of "multilateral FTAs" and "*ROW* FTAs" – in the spirit of Anderson and van Wincoop's (2003) "multilateral resistance" terms. We found that the marginal response probabilities of these indexes of "own-FTA" and "third-country-pair-FTA" competitive liberalization effects were both statistically and economically significant – and on the order of magnitude of the effects of country-pairs' GDP sizes on the likelihood of two countries forming an FTA. Moreover, using a "Sensitivity-Specificity" analysis, we determined the optimum cutoff probability for predicting FTAs and the results indicated that we could predict correctly an FTA ("No-FTA") when one existed (none existed) 91 percent of the time. The results provide economically and statistically significant evidence that "tariff complementarity" is at least as important as "competitive liberalization" as a source of the growth of bilateralism.

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8 Appendix A

(*Not Intended for Publication*)

This appendix is designed to provide intuition for constructing $MDIST_i$ and $MCONT_i$. It is clear from B-B and the above that the factors that tend to explain whether or not two countries tend to have an FTA in a given year are the same factors that tend to explain their bilateral trade values cross-sectionally. In the context of B-B, country pairs that have FTAs in 1996 have "chosen well," as the pairs that have selected into agreements tend to have the economic characteristics that suggest they will on net benefit from an FTA – and they also have large trade flows. In other words, country-pairs that select into bilateral FTAs tend to have the *same economic characteristics* that determine the volume of their bilateral trade flows.

It is useful then to note that – in the spirit of Anderson and van Wincoop (2003) – the model described earlier can be shown to yield the bilateral trade flow between a pair of countries ij as determined by:

$$X_{ij} = \frac{Y_i Y_j}{Y^W} \left(\frac{t_{ij}\tau_{ij}}{P_i P_j} \right)^{1-\sigma} \tag{21}$$

where X_{ij} is the (aggregate) bilateral trade flow from i to j, Y_i (Y_j) is GDP, Y^W is world GDP, and:

$$P_i = \sum_{k=1}^{N} \theta_k P_k^{\sigma-1} t_{ik}^{1-\sigma} \tau_{ik}^{1-\sigma} \tag{22}$$

under the assumption of bilaterally symmetric trade costs ($t_{ij} = t_{ji}$, $\tau_{ij} = \tau_{ji}$).[34]

Variables P_i and P_j are interpreted in the model's context as "multilateral price" terms. For instance, any factor tending to lower exporter i's multilateral price P_i – such as the formation of an FTA between i and some country k – will tend to increase trade between i and k, since $\sigma > 1$; an analogous rationale applies to P_j. Consequently, measures of P_i and P_j are useful. Unfortunately, prices are endogenous in this general equilibrium model and measures of P_i and P_j are simply not readily observed. A solution to this dilemma was offered in Baier and Bergstrand (2006, 2009), which applied a first-order log-linear Taylor-series expansion to the N multilateral price terms P_i above and demonstrated that this linear approximation yielded a gravity equation:

$$X_{ij} = \frac{Y_i Y_j}{Y^W} \left(\frac{t_{ij}\tau_{ij}}{t_i \tau_i t_j \tau_j} \right)^{1-\sigma}. \tag{23}$$

where $lnt_i = \sum_k^N \theta_k lnt_{ik} - 0.5 \sum_k^N \sum_l^N \theta_k \theta_l lnt_{kl}$, $ln\tau_i = \sum_k^N \theta_k ln\tau_{ik} - 0.5 \sum_k^N \sum_l^N \theta_k \theta_l ln\tau_{kl}$, $lnt_j = \sum_k^N \theta_k lnt_{kj} - 0.5 \sum_k^N \sum_l^N \theta_k \theta_l lnt_{kl}$, $ln\tau_j = \sum_k^N \theta_k ln\tau_{kj} - 0.5 \sum_k^N \sum_l^N \theta_k \theta_l ln\tau_{kl}$, ln de-

[34] The model can also be solved in the case of bilaterally asymmetric trade costs; however, all the trade-cost variables in our empirical specification later will be bilaterally symmetric, so we adopt this simpler specification here.

notes the natural logarithm operator, and $\theta_k = Y_k/Y^W$. In Baier and Bergstrand (2009), the expansion was centered around a "frictionless" world ($t_{ij} = 1$).

In most gravity-equation analyses of international trade flows, t_{ij} and τ_{ij} are unobservable. Typically, one assumes $t_{ij} = DISTANCE_{ij}^{\rho}$ and $\tau_{ij} = e^{-\psi FTA_{ij}}$ where $DISTANCE_{ij}$ denotes bilateral distance between i and j, FTA_{ij} is a binary variable having a value of 1 (0) if an FTA exists (does not exist), and e is the natural logarithm base, cf., Anderson and van Wincoop (2003, 2004) and Baier and Bergstrand (2009). Consequently, observable multilateral measures of the log of $DISTANCE$, $DIST$ as in the text, for i and j (ignoring the t subscript), respectively, are:

$$MDIST_i = \sum_k^N \theta_k DIST_{ik} - \sum_k^N \sum_l^N \theta_k \theta_l DIST_{kl} \tag{24}$$

and

$$MDIST_j = \sum_k^N \theta_k DIST_{jk} - \sum_k^N \sum_l^N \theta_k \theta_l DIST_{kl}. \tag{25}$$

where the second RHS term in each equation is a constant. For completeness, we can define also the multilateral (resistance) $CONT$ terms:

$$MCONT_i = \sum_k^N \theta_k CONT_{ik} - \sum_k^N \sum_l^N \theta_k \theta_l CONT_{kl} \tag{26}$$

and

$$MCONT_j = \sum_k^N \theta_k CONT_{jk} - \sum_k^N \sum_l^N \theta_k \theta_l CONT_{kl}. \tag{27}$$

where again the second RHS term in each equation is a constant.

Baier and Bergstrand (2006) also considered an expansion centered around a "symmetric" equilibrium, i.e., $t_{ij} = t$ and $\theta_i = 1/N$. Under this expansion, the variables above are simple averages, such as:

$$MDIST_i = \frac{1}{N} \sum_k^N DIST_{ik} - \frac{1}{N^2} \sum_k^N \sum_l^N DIST_{kl} \tag{28}$$

and analogously for the other variables. Thus, Baier and Bergstrand (2009) suggest *theory-based* variables to reflect "remoteness" instead of the *ad hoc* variable $REMOTE$ used in Baier and Bergstrand (2004), Baldwin and Jaimovich (2008), Egger and Larch (2008), and Bergstrand, Egger, and Larch (2009).

Fig. 1: Percent Change in 1A's Utility from a Natural (Top) or Unnatural (Bottom) FTA

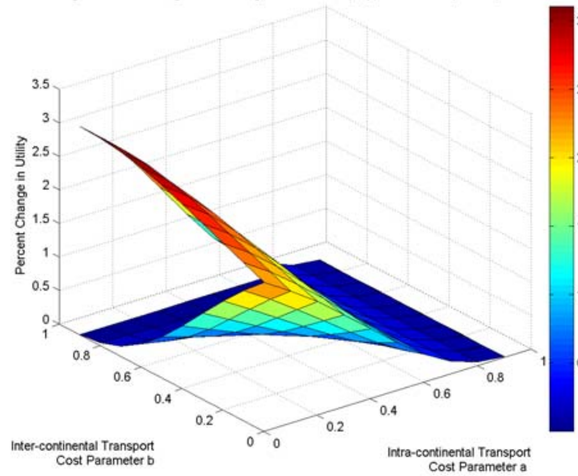

Fig. 2: Percent Change in 1A's Utility from an FTA Between Large (Top) or Small (Bottom) Economies

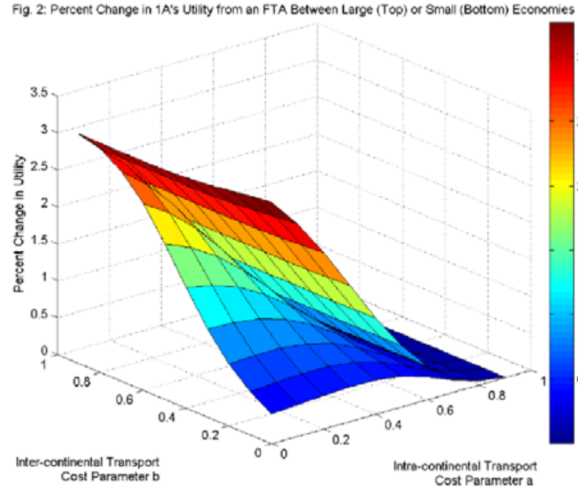

Fig. 3: Percent Change in 1A's Utility from an FTA between Similarly Sized (Top) Economies or Dissimilarly Sized (Bottom) Economies

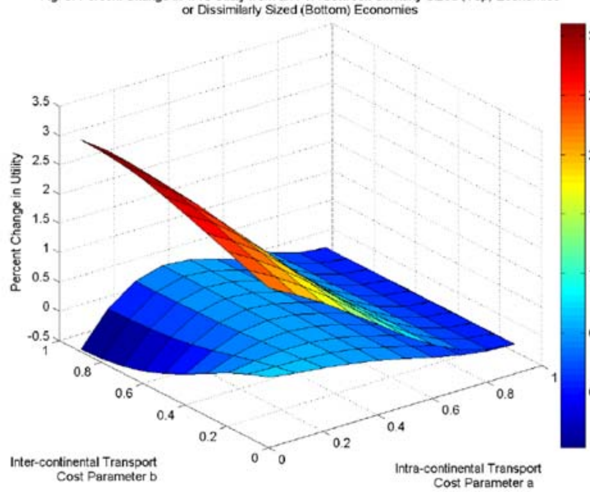

Figure 4a: Hypothesis 4 (Competitive Liberalization)

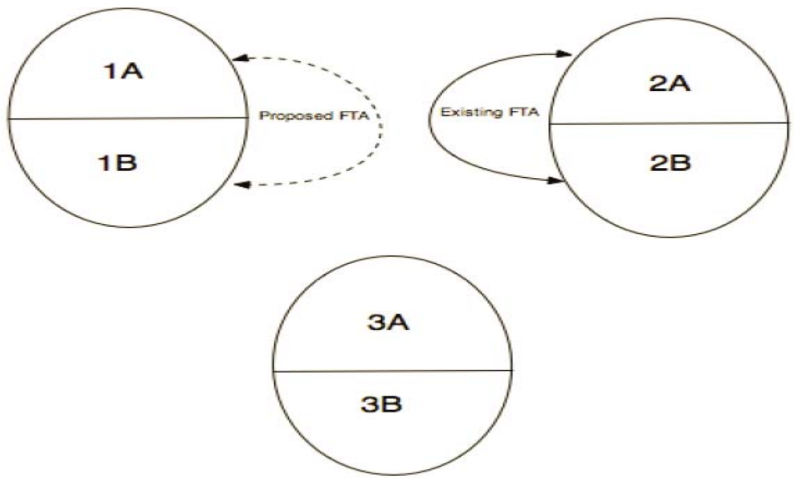

Figure 4b: Hypothesis 5 (Tariff Complementarity)

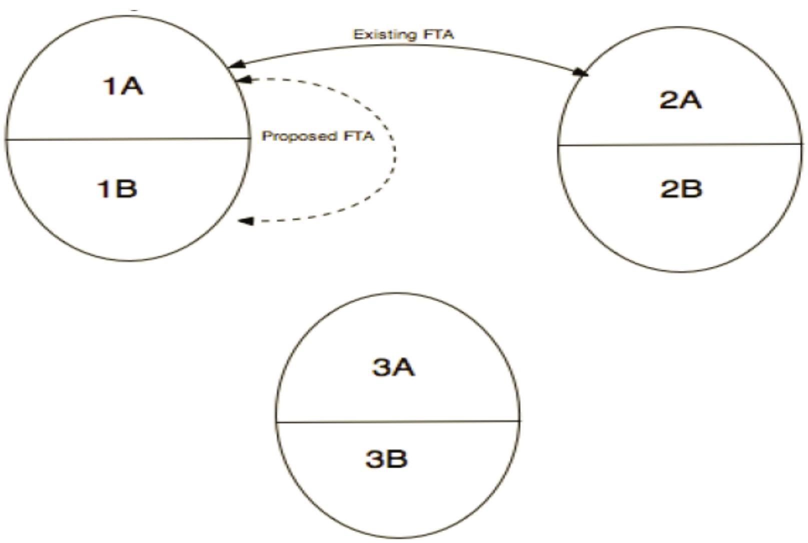

Fig.5a: Percent Gain in 1A's Utility from FTA (1A,1B)
Conditional on FTA (2A,2B)(Top) and from FTA (1A,1B) Unconditional(Bottom)

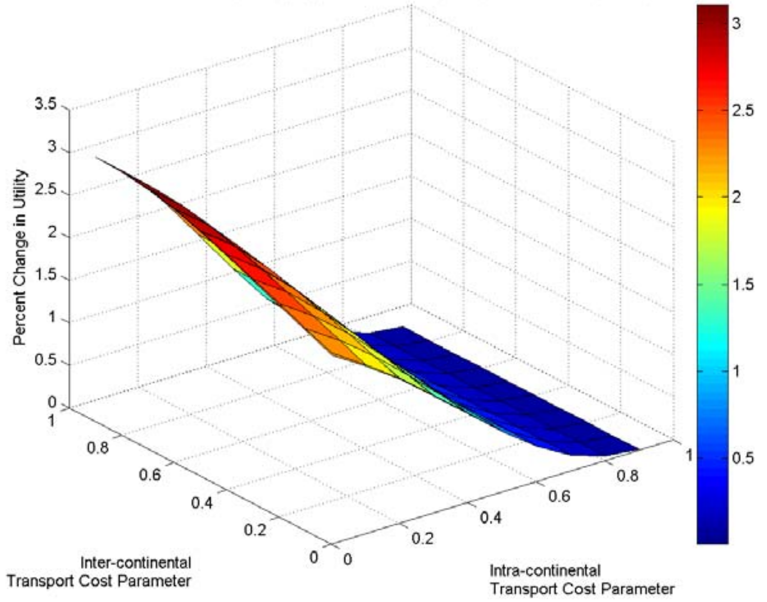

Fig.5b: Percent Gain in 1A's Utility from FTA(1A,1B),
Due to FTA(2A,2B)

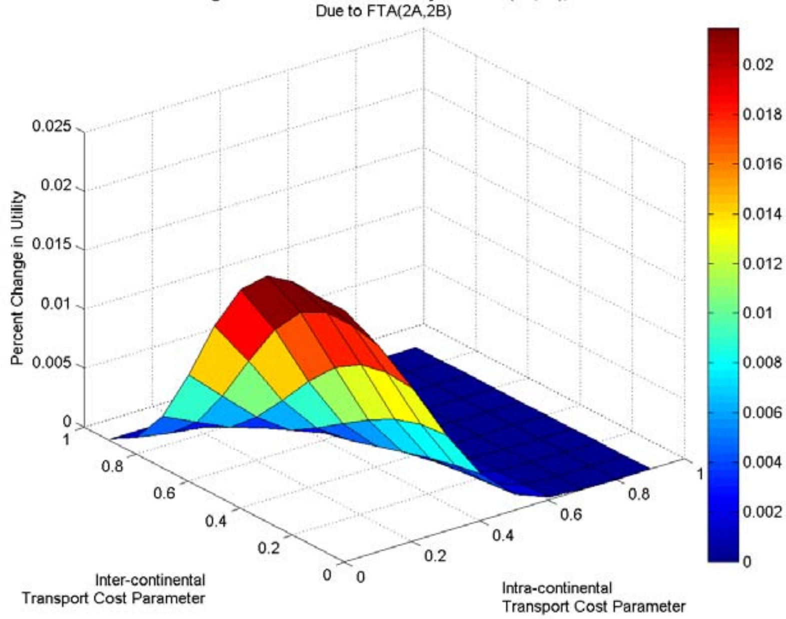

Fig. 6a: Percent Change in 1A's Utility from FTA (1A,1B)
Conditional on FTA (1A, 2A)(Top) and from FTA (1A,1B) Unconditional(Bottom)

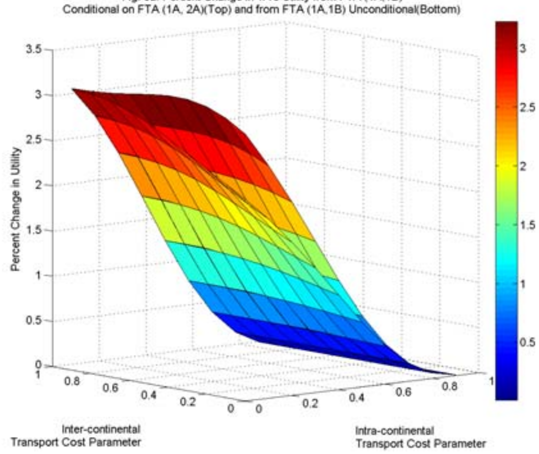

Fig.6b: Percent Change in 1A's Utility from FTA (1A,1B) Owing to FTA(1A,2A)

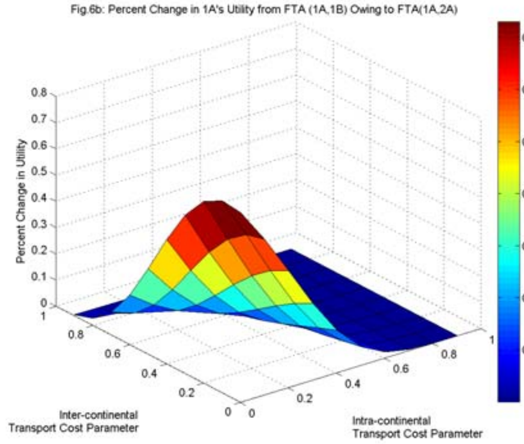

Fig.6c: Percent Change in 2A's Utility from FTA (1A,2A)
Conditional on FTA (1A,1B)

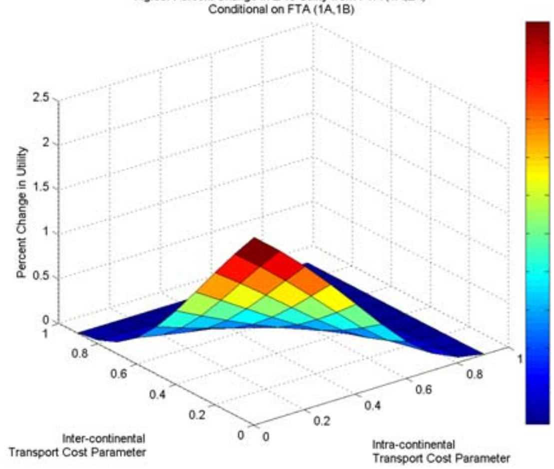

Figure 7a

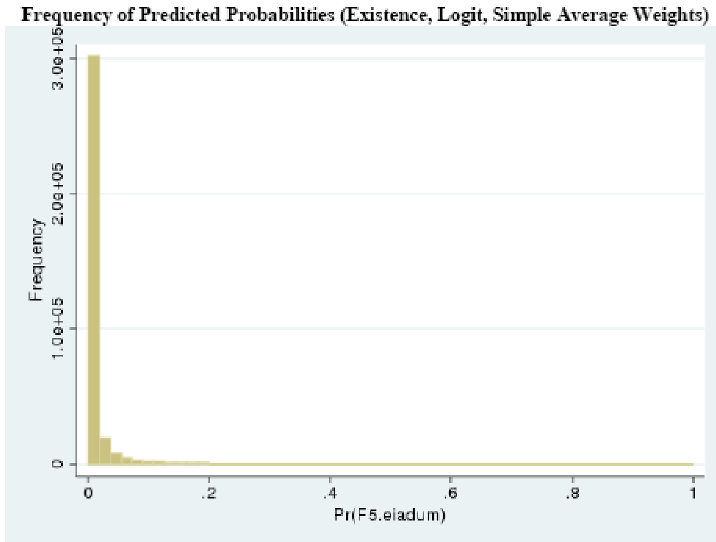

Figure 7b

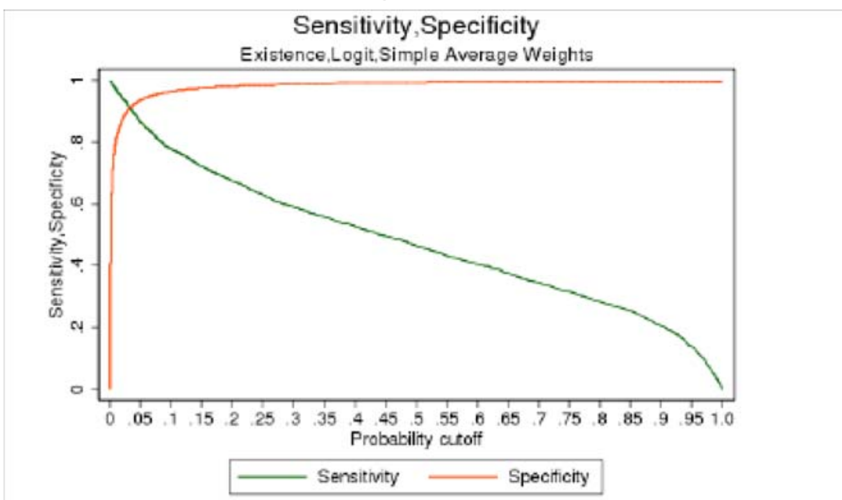

Figure 7c

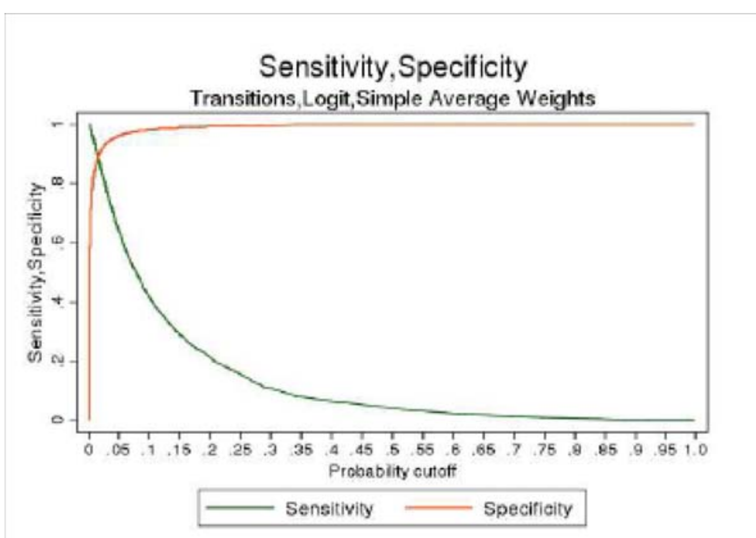

Figure 8a

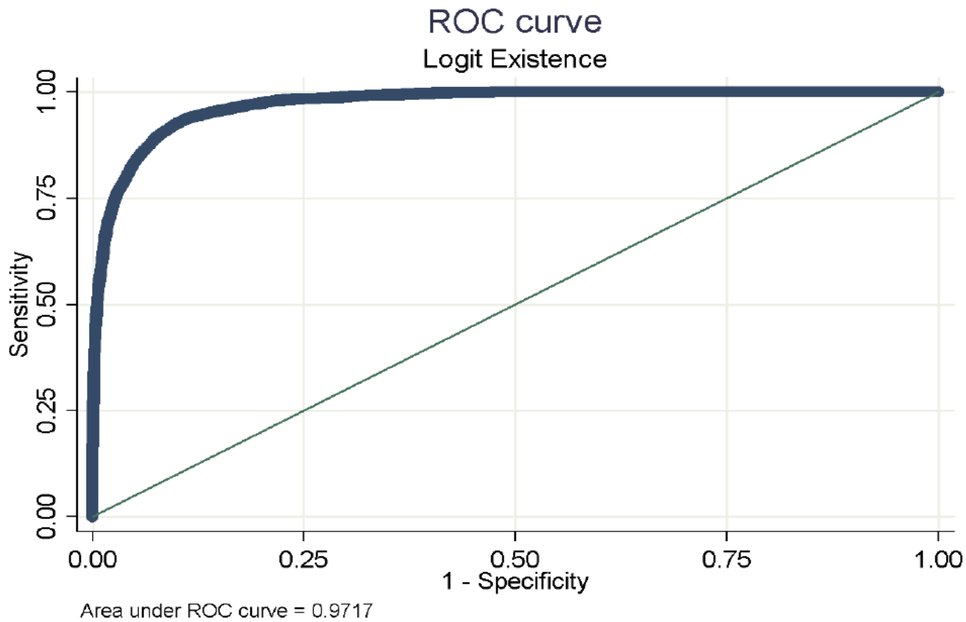

Figure 8b

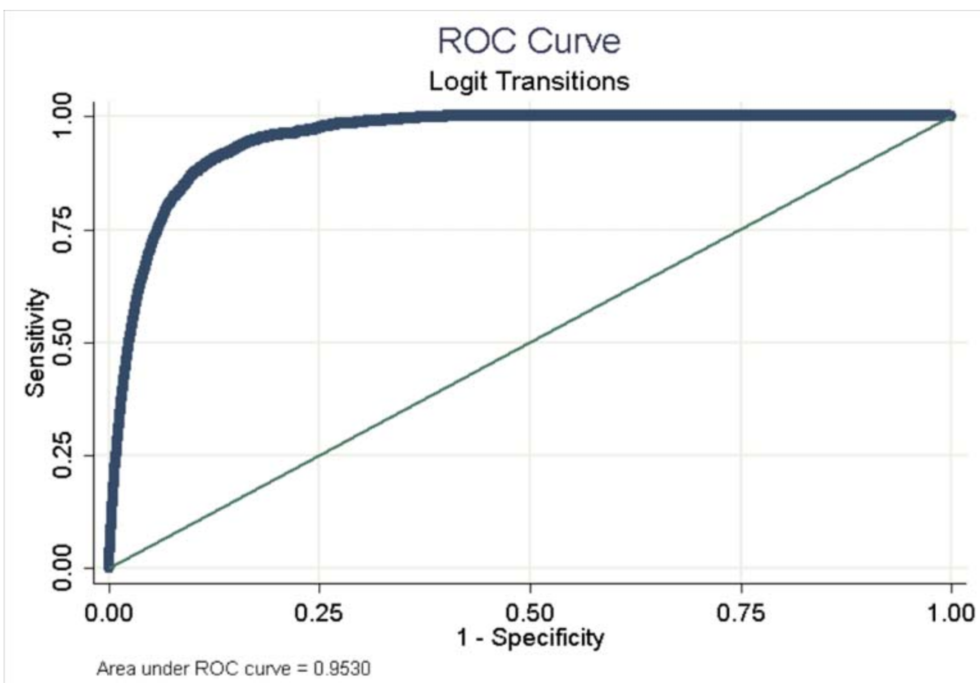

Table 1[a]

Data Description

Integration Index	Count	Percent of Total	Percent of Subtotal
0 (None)	336,640	69.1	85.8
1 (1-way PTA)	33,821	7.0	8.6
2 (2-way PTA)	11,035	2.3	2.8
3 (FTA)	7,498	1.5	1.9
4 (Customs Union)	1,547	0.3	0.4
5 (Common Market)	1,085	0.2	0.3
6 (Economic Union)	643	0.1	0.2
Subtotal	392,269	—	100.0
Missing observations	94,641	19.5	
Total	486,910	100.0	

[a]Total observations are based upon 146 countries (146 × 145/2 = 10,585 pairings) for 46 years (1960-2005). Missing data refers to country pairs where in a given year one of two countries did not officially exist. See data source at www.nd.edu/~jbergstr.

Table 2[a]

Variables	Expected Sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
$DIST_{ij}$	-	-1.02*	-1.30*	-1.54*	-1.24*	-0.72*	-1.59*	-1.59*	-0.74*	-0.70*	—	—	—	—
		(-59.26)	(-66.97)	(71.65)	(-46.42)	(-74.67)	(-77.35)	(-35.42)	(-86.64)	(-58.87)				
$MDIST_{ij}$	+	-2.95*	-1.39*	0.25*	-0.36*	-0.03	0.36*	0.39*	-0.44*	-0.96*	—	—	—	—
		(-75.42)	(-37.37)	(5.56)	(-6.08)	(-1.40)	(8.86)	(4.32)	(-12.03)	(-18.63)				
$CONT_{ij}$	+	1.71*	1.45*	1.65*	1.43*	0.85*	1.57*	1.54*	1.87*	1.79*	—	—	—	—
		(50.78)	(41.53)	(40.72)	(27.85)	(45.68)	(40.36)	(18.74)	(59.79)	(41.36)				
$MCONT_{ij}$	-	-10.07*	-4.11*	-0.85*	-2.40*	-0.80*	-0.48	-0.90*	-2.91*	-4.12*	—	—	—	—
		(-67.73)	(-26.70)	(-5.10)	(-11.07)	(-9.79)	(-5.93)	(-2.70)	(-19.79)	(-20.77)				
$SUMGDP_{ij,t-5}$	+	—	0.80*	0.51*	0.49*	0.24*	0.48*	0.50*	0.37*	0.39*	3.20*	3.43*	2.81*	4.86*
			(79.20)	(44.79)	(34.54)	(42.96)	(32.85)	(21.51)	(39.00)	(29.69)	(14.08)	(12.32)	(6.05)	(7.34)
$DIFGDP_{ij,t-5}$	-	—	-0.56*	-0.51*	-0.42*	-0.24*	-0.47*	-0.53*	-0.44*	-0.39*	0.40	0.16	-0.10	-1.00*
			(-50.73)	(-40.67)	(-27.18)	(-40.12)	(-37.97)	(-20.72)	(-42.65)	(26.74)	(1.66)	(0.56)	(-0.33)	(-2.41)
$MFTA_{i,t-5(i\neq j)}$	+	—	—	0.09*	0.02*	0.05*	0.06*	0.09*	0.07*	0.01*	0.35*	0.84*	0.33*	0.97*
				(45.68)	(8.47)	(45.18)	(59.76)	(23.37)	(44.87)	(5.80)	(11.20)	(10.36)	(13.64)	(13.13)
$MFTA_{j,t-5(j\neq i)}$	+	—	—	0.12*	0.05*	0.06*	0.06*	0.11*	0.09*	0.04*	0.45*	0.88*	0.36*	0.84*
				(57.17)	(19.48)	(56.13)	(61.83)	(27.78)	(55.24)	(17.14)	(11.56)	(10.90)	(13.33)	(12.41)
$ROWFTA_{ij,t-5}$	+	—	—	0.0004*	0.002*	0.0002*	0.22*	0.0004*	0.00004	0.001*	0.009*	0.01*	0.01*	0.01
				(9.71)	(26.31)	(12.45)	(31.01)	(5.32)	(0.90)	(25.56)	(22.97)	(20.86)	(22.42)	(1.03)
CONSTANT		-116.17*	-50.03*	-13.69*	-33.08*	-11.27*	-6.01*	-14.90*	-41.27*	-55.69*	—	—	—	—
		(-60.61)	(-24.99)	(-6.31)	(-11.82)	(-10.67)	(-14.13)	(-3.44)	(-21.76)	(-4.83)				
Pair Fixed Ef.		No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Yr Dummies		No	No	No	No	No	No	No	No	No	No	No	Yes	Yes
No. Observ.		358,767	358,767	358,767	352,002	358,767	358,767	77,059	358,767	352,002	358,767	352,002	358,767	352,002
No. Pos. Obs.		10,478	10,478	10,478	3,811	10,478	10,478	2,490	10,478	3,811	10,478	3,811	10,478	3,811
No. Neg. Obs.		348,289	348,289	348,289	348,191	348,289	348,289	74,569	348,289	348,191	348,289	348,191	348,289	348,191
Random Prob.		0.029	0.029	0.029	0.011	0.029	0.029	0.032	0.029	0.011	0.029	0.011	0.029	0.011
Pseudo R^2		0.39	0.46	0.56	0.34	0.57	0.56	0.56	0.54	0.32	0.80	0.73	0.87	0.85
log-likelihood		-28,953	-25,359	-20,663	-13,860	-20,587	-20,759	-4,792	-21,832	-14,260	-2,294	-2,034	-1,525	-1,142

[a]*denotes statistical significance in one-tail t-test (or z-test) at 1 percent level.

Table 3a

Natural Trading Partners Existence							Percentage Points Pr(FTA=1|X+σ) -Pr(FTA=1|X)
	P(FTA_t=1| CONT=1)=	0.1031		95% Confidence Interval 0.0995	0.1068		
	Pr(FTA=1|X-σ)	95% C.I.		Pr(FTA=1|X+σ)	95% C.I.		
DIFGDP	0.1494	0.1437	0.1551	0.0706	0.0678	0.0734	-0.0325
SUMGDP	0.0716	0.0688	0.0744	0.1474	0.142	0.1529	0.0443
DIST	0.1709	0.1648	0.1769	0.0612	0.0589	0.0636	-0.0419
MDIST	0.0982	0.0943	0.1021	0.1083	0.1041	0.1124	0.0051
MCONT	0.1078	0.1036	0.112	0.0986	0.0948	0.1025	-0.0045
MFTAi	0.0812	0.0782	0.0841	0.1306	0.1259	0.1353	0.0275
MFTAj	0.0766	0.0738	0.0794	0.1381	0.1332	0.143	0.035
ROWFTA	0.0966	0.0929	0.1002	0.1101	0.106	0.1142	0.007
MFTAi*	0.0989	0.0954	0.1024	0.1075	0.1037	0.1113	0.0044
MFTAj*	0.098	0.0945	0.1014	0.1085	0.1047	0.1124	0.0054
ROWFTA*	0.1031	0.0994	0.1067	0.1032	0.0995	0.1068	0.0000
σ=1 S.D. for (first 9 variables); σ=count of 1 for MFTAi* and MFTAj*, σ=count of 2 for							ROWFTA*

Table 3b

Unnatural Trading Partners Existence							Percentage Points Pr(FTA=1|X+σ) -Pr(FTA=1|X)
	P(FTA_t=1| CONT=0)=	0.0066		95% Confidence Interval 0.0061	0.0071		
	Pr(FTA=1|X-σ)	95% C.I.		Pr(FTA=1|X+σ)	95% C.I.		
DIFGDP	0.0133	0.0122	0.0143	0.0032	0.0029	0.0034	-0.0034
SUMGDP	0.0032	0.003	0.0035	0.013	0.012	0.014	0.0064
DIST	0.0171	0.0158	0.0183	0.0024	0.0022	0.0026	-0.0042
MDIST	0.006	0.0055	0.0065	0.0072	0.0066	0.0078	0.0006
MCONT	0.0072	0.0066	0.0078	0.006	0.0055	0.0065	-0.0005
MFTAi	0.0041	0.0038	0.0045	0.0103	0.0095	0.0111	0.0037
MFTAj	0.0037	0.0034	0.004	0.0115	0.0106	0.0123	0.0049
ROWFTA	0.0058	0.0053	0.0063	0.0075	0.0069	0.008	0.0009
MFTAi*	0.0061	0.0056	0.0065	0.0071	0.0066	0.0077	0.0005
MFTAj*	0.006	0.0055	0.0064	0.0073	0.0067	0.0078	0.0007
ROWFTA*	0.0066	0.0061	0.0071	0.0066	0.0061	0.0071	0.0000
σ=1 S.D. for (first 9 variables); σ=count of 1 for MFTAi* and MFTAj*, σ=count of 2 for							ROWFTA*

Table 4a

The following predictions are from Logit, MFTA count regression, with years in multiples of 5 only. Independent variables are in t-5.

Correctly Predict FTA Existence in year t (FTA_t=1) using MFTA and ROWFTA variables									
	Cutoff from Sens,Sp		TrueNeg.Rate=97%		TrueNeg.Rate=99%		Prob. Cutoff at 50%		
Year t	Percent Correct	Correctly Predicted	Percent Correct	Correctly Predicted	Percent Correct	Correctly Predicted	Percent Correct	Correctly Predicted	Observed
1960	83.87	26	38.71	12	30.96	1	3.23	1	31
1965	75.44	43	56.14	32	56.98	6	10.53	6	57
1970	82.93	34	65.85	27	19.51	8	17.07	7	41
1975	86.54	90	62.50	65	22.12	23	21.15	22	104
1980	88.46	92	84.62	88	56.73	59	56.73	59	104
1985	87.22	116	75.94	101	46.62	62	45.86	61	133
1990	94.30	149	81.65	129	57.59	91	56.96	90	158
1995	93.96	280	76.85	229	45.97	137	44.30	132	298
2000	91.79	570	76.17	473	50.40	313	50.08	311	621
2005	91.94	867	76.78	724	51.64	487	51.22	483	943
Total	91.04	2267	75.50	1880	47.67	1187	47.07	1172	2490
Cutoff		0.039		0.1344		0.49		0.5	

Table 4b

The following predictions are from Logit, (No-MFTA) count regression, with years in multiples of 5 only. Independent variables are in t-5.

Correctly Predict FTA Existence in year t (FTA_t=1) without MFTA and ROWFTA variables									
	Cutoff from Sens,Sp		TrueNeg.Rate=97%		TrueNeg.Rate=99%		Prob. Cutoff at50%		
Year t	Percent Correct	Correctly Predicted	Percent Correct	Correctly Predicted	Percent Correct	Correctly Predicted	Percent Correct	Correctly Predicted	Observed
1960	100.00	31	90.32	28	51.61	16	41.94	13	31
1965	89.47	51	61.40	35	29.82	17	26.32	15	57
1970	97.56	40	73.17	30	48.78	20	41.46	17	41
1975	95.19	99	81.73	85	45.19	47	38.46	40	104
1980	98.08	102	82.69	86	47.12	49	43.27	45	104
1985	98.50	131	81.95	109	43.61	58	38.35	51	133
1990	98.10	155	83.54	132	44.94	71	40.51	64	158
1995	98.32	293	79.19	236	40.94	122	34.23	102	298
2000	88.24	548	63.93	397	29.95	186	25.76	160	621
2005	79.53	750	51.86	489	23.33	220	21.00	198	943
Total	88.35	2200	65.34	1627	32.37	806	28.31	705	2490
Cutoff		0.027		0.1368		0.45		0.5	